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STATE OF NEVADA

DEPARTMENT of HIGHWAYS

1923-1924

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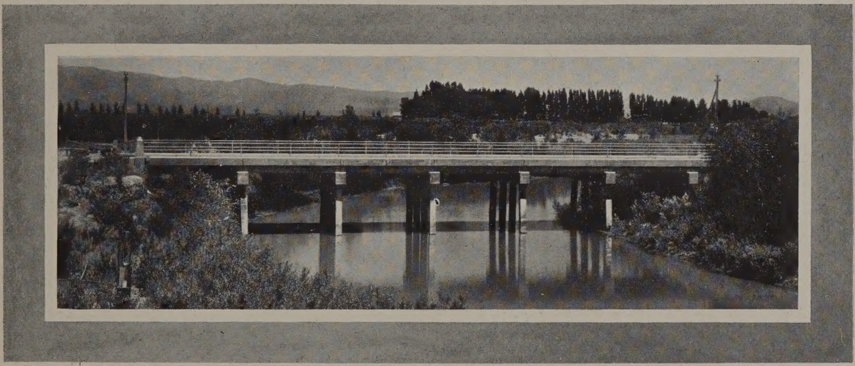
STATE OF NEVADA

FOURTH BIENNIAL REPORT

OF THE

DEPARTMENT OF HIGHWAYS

1923-1924



CARSON CITY, NEVADA
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1925

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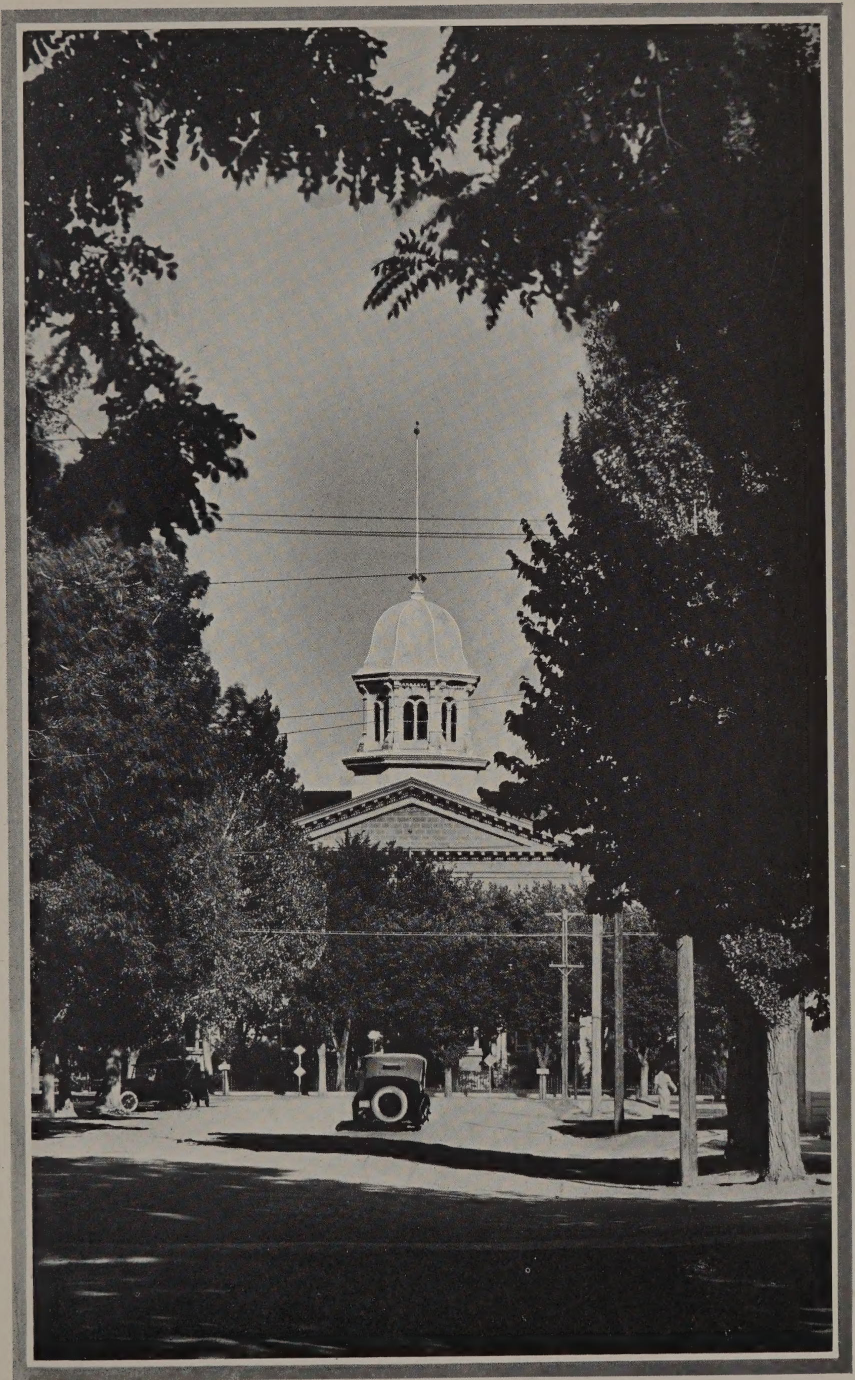

NEVADA'S CAPITOL

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LETTER OF TRANSMITTAL

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS
CARSON CITY, NEVADA, January 1, 1925.

To HONORABLE JAMES G. SCRUGHAM, *Governor of the State of Nevada.*

DEAR SIR: We take pleasure in presenting herewith, in accordance with statute requirement, the fourth biennial report of the Department of Highways. This report covers the fiscal years 1923 and 1924, beginning with December 1, 1922, and ending with November 30, 1924.

In this report we have endeavored to set forth, in brief form, the work accomplished by the Department during the biennial period just past, and are also setting forth what is hoped to be accomplished during the forthcoming two years, as well as bringing to your attention certain recommendations affecting the further conduct of state highway construction in the State of Nevada.

To yourself and all members of your administration we wish to express our sincere appreciation of the splendid and helpful cooperation which has been shown throughout in the conduct of the affairs of this Department.

Respectfully,

JAMES M. LEONARD, *Chairman.*
W. H. JOHNSTON, *Director.*
GEO. A. CAMPBELL, *Director.*

A Typical Highway Project in Nevada

PERSONNEL OF THE DEPARTMENT OF HIGHWAYS

ADMINISTRATION

James M. Leonard	Chairman Board of Directors
W. H. Johnston	Director
Geo. A. Campbell	Director
Geo. W. Borden	State Highway Engineer
Howard M. Loy	Assistant State Highway Engineer
Floyd O. Booe	Auditor and Secretary to the Board

DEPARTMENTS AND DIVISIONS

H. F. Holley	Engineer of Surveys and Designs
P. L. Boneysteele	Maintenance Engineer
W. P. Harrington	Supervisor of Employment, Adjustments and Public Relations
T. J. Collins	Equipment Superintendent
W. T. Holcomb	Testing Engineer
R. Windele	Location Engineer
H. D. Mills	Rights-of-Way Engineer
J. M. Kane	Chief Draftsman
C. C. Boyer	Division Engineer, Division No. 1
E. T. Hinshaw	Division Engineer, Division No. 2
S. C. Durkee	Division Engineer, Division No. 3

INTRODUCTION TO NEVADA'S HIGHWAYS

A MESSAGE TO THE PUBLIC

NEVADA HEROES MEMORIAL BUILDING
Highway Department Headquarters, Carson City, Nevada

GEO. W. BORDEN,
State Highway Engineer

REPORT OF THE DEPARTMENT OF HIGHWAYS

INTRODUCTORY

Highway construction in Nevada reached its peak during the years 1923–1924, and this biennium represents the greatest two-year construction program so far attempted by the Nevada State Highway Department. During the biennial period highway construction was so increased that results obtained in completed mileage were nearly double that of all previous similar periods. At the end of 1922 we had complete and under contract 432.61 miles of state highway, 23 miles of forest roads, and 2,031 linear feet of bridges. In the biennium 1923–1924 the totals were swelled to the extent that we now have 915.11 miles of highways of various types complete and under contract, and 3,436 linear feet of bridges, with seven grade separation structures for the purpose of separating railroad and highway traffic, the approximate cost of this entire operation amounting to $10,892,568.58.

Of the 915.11 miles mentioned above, 769.5 miles are completed state highways at this time. This completed mileage is divided into various types as follows:

Highway surfaced with gravel, shale, or crushed rock, 510.2 miles, costing an average of $8,412.67 per mile; 45.1 miles of cement concrete surfaced highway with an average cost per mile of $44,150.36; 24 miles of asphalt macadam (penetration method) which averages $25,490.11 per mile; 178.4 miles of graded road, not surfaced, costing $7,560.04 per mile; 1.6 miles of asphaltic concrete, costing $43,421.10 per mile; and 10.2 miles of oiled sand road costing $9,314 per mile.

This mileage is distributed over the State in the following manner:

For the East and West Roads

Route No. 1, leading from the Utah line, through Elko, Winnemucca, Lovelock, and Reno, to the California line near Verdi, has complete and under construction 239.89 miles.

Route No. 2, from the Utah state line, through Ely, Eureka, Austin, Fallon, and connecting with Route No. 1 east of Reno, has complete and under construction 238.94 miles.

Route No. 6, from the Arizona line on the east, near Mesquite, through Las Vegas, to the California line, now has complete or under construction 71.06 miles, almost closing the gap between the east state line and the city of Las Vegas.

Route No. 4, from Ely to Tonopah, has, through the efforts of the Federal Forest Service, the county of Nye, and the State Highway Department, been placed in excellent travelable condition for almost the entire distance of 175 miles.

For the North and South Roads

There is now complete or under construction, from Purdy, via Reno, Minden, Yerington, Tonopah, and Goldfield to Las Vegas, 199.04 miles.

For Routes Nos. 8 and 8-A, leading from McDermitt, or Denio, on the Oregon state line, through Winnemucca, Austin, to Tonopah, a start has been made towards construction, and there is now complete 33.12 miles of this highway.

Route No. 7, leading from Ely to Las Vegas, via Moapa, is developing rapidly into an improved highway and has complete at the present time 48.18 miles of its length.

This statement of mileage and location of construction indicates that we are rapidly approaching a time when we can see the completion of at least 1,500 miles of our State Highway System. This mileage will offer an excellent foundation for further highway expansion in the State after the completion of the seven per cent federal-aid highway system as now designated.

The State Highway Department, during the past four years, has been very carefully maintaining its various state projects, and a very accurate record of the cost of such maintenance has been kept. One reason we had in mind in keeping an accurate record of maintenance costs was to arrive at the average cost per mile, such average costs to be used as a basis for estimating future costs of similar work. We realize that the investment life of all expenditures in highway construction very materially depends upon proper maintenance, and the funds required to meet the increasing annual cost of maintenance must be taken into consideration in further plans of financing extensions and additions to the mileage of completed highways.

We have found that the average cost of maintenance per mile of highways constructed by the State of Nevada will approximate $250 per mile, and the Highway Department is budgeting its future maintenance activities on that basis.

Through the passage of the Dowell Bill, now pending before Congress, and with the approval of the annual appropriation bills covering the next two years, the federal funds necessary for the continuation of state highway construction in the State seem assured. There is no reason at this time to anticipate any great additional tax burden for carrying on state highway activities. Funds provided through taxation now in effect we believe will be ample to carry on the program on a basis comparable with the rate of progress established during past years.

Again we wish to express our appreciation of the very commendable manner in which the Department of Agriculture, through its Bureau of Public Roads, cooperated with and assisted us in our program of highway construction under the federal highway law, and in this connection we particularly wish to mention C. H. Sweetser, District Engineer, Division 2, Bureau of Public Roads, of San Francisco, Calif., and those associated with him in the district office. To them we wish to extend our thanks for the very able and efficient manner in which they have assisted us.

We have endeavored in the following chapters to set forth a brief and comprehensive report of the various activities of the Department of Highways, and we trust that the information therein contained will be of interest to those who are interested in highway improvement in this State.

LEGISLATIVE RECOMMENDATIONS

In the conduct of operations as extensive in character as those carried on by the State Highway Department, of necessity many contacts are established and the need for certain remedial legislation perhaps noticed before the general public becomes aware of such need. This would apply particularly to such matters as traffic regulations, motor-vehicle licensing, bill-board advertising, and matters of similar character.

As a part of the biennial report, therefore, the Board of Directors and the State Highway Engineer feel that it is proper to call these matters to the attention of the Legislature and the general public, and to make to the Governor and the Legislature certain definite recommendations along this line.

For the consideration of the Governor and the Legislature we, therefore, submit the following as our recommendations on these various matters:

First—We believe that in order to provide the proper road service to interstate tourist travel passing north and south in eastern Nevada, the road from Currie, in White Pine County, northward through Wells and Contact in Elko County to the Idaho line south of Rogerson, should be placed on the State Highway System. This would mean the addition to the existing State Highway System of approximately 140 miles. While this mileage could not at this time be added to the federal-aid seven per cent system, it would be in line for such addition to this system at the proper time and would undoubtedly serve as a means of securing some state and county work on this route at an early date. Your attention is called to the fact that already tourist travel over this route between southern California and the Yellowstone Park region is quite heavy and with the activities of the various chambers of commerce and highway tourist associations interested will become of increasing importance each year.

Second—We also recommend that the Legislature of 1925 add to the State Highway System the route from a point approximating Conner's Pass on the Ely-Pioche Route, to the Lehman Caves, through Baker and to the Utah state line. Such route, if added, will at once be designated as a part of the federal-aid seven per cent system and will be immediately in line for construction through the use of federal-aid funds with the probability of such construction being taken up at once. This route is recommended as a part of the solution of the problem of an interstate connection between Nevada and Utah as an outlet for travel passing over Route 2 through the central portion of the State. Cooperative action on the part of the State of Utah to make the road in Utah through Delta, Santaquin, and Provo into Salt Lake City a state highway will be sought. A part of this route is now under way. We believe the project will receive the full support of the Ely territory, can be approved by the Bureau of Public Roads, and that it will also be supported by the automobile clubs and various civic organizations of northern California.

Third—It was undoubtedly the intent of the Legislature of 1923 to divide the income from the gasoline tax equally between the State and the counties. This is evidenced by the fact that the estimated annual income at that time was placed at $120,000, and the bill as passed made provisions that $60,000 go into the State Highway Fund, the balance to be pro rated among the counties. The gross collections for 1923 were $120,953.14, $60,000 of which went to the State Highway Fund and approximately $45,000, which was the balance remaining after refunds were settled, was pro rated among the counties. The 1924 gross income has totaled approximately $166,000, and after the state's share of $60,000 is deducted and refunds are paid, the counties will receive in excess of $100,000. To make the division on an equitable basis, therefore, the gasoline-tax law should be amended to provide that 1 cent of the levy should go to the State and 1 cent to the counties, the collection of the tax to be made as at present and the amounts refunded to be deducted proportionately from the total income. No increase in the gasoline-tax rate is recommended by this Department.

Fourth—We recommend the entire revamping of the motor-vehicle law as the present law is entirely inadequate and is the result of so many successive amendments that it does not fit conditions as they are today. This subject is fully covered elsewhere in this report, but we at this time call attention to the following features of the law which require attention:

Application for license through the County Assessors.

Abolition of the ninety-day permit for competitive commercial vehicles entering from other States.

Application for license to serve as tax clearance on car or truck.

Change of the tail-light feature to provide green as the running light, and red to be used only as a stop signal.

Surplus fees from license income beginning with 1925 to go to the State Highway Fund.

A refund to be made to Storey County covering the amount of license fees received from said county. This provision would be the same as was in effect prior to the amendment of section 7 by the Session of 1923.

Fifth—Legislation to curb the running of stray and loose live stock on the highways, such stock on the paved roads representing a real menace to life and having during the past several years resulted in several serious accidents. The present laws on this subject seem entirely inadequate.

Sixth—The enactment of a statute curbing the advertising billboard evil along our highways.

Seventh—The clarifying of the State Highway Law in that section relating to the filing of creditor's claims against a contractor. The present wording of the law is such that the Department is at a loss to determine the real intent of the law. Consultation with the Attorney-General should result in a wording of this section that would be clear and complete.

Eighth—The remainder of the automobile license fees over and above the annual requirements for meeting the State Highway Bond interest and redemption schedule should be transferred promptly each month, after the foregoing requirements have been met, to the State Highway Fund. This will require that the existing provision of section 7 of the present motor-vehicle law be amended to make this feature a permanent part of the Act.

Ninth—Proper legislative action which will permit the State Treasurer and the Controller to extend to the State Highway Department at any and all times a credit equivalent to 75 per cent of the total amount of the federal-aid vouchers submitted to the District Engineer of the Bureau of Public Roads, and in process of payment. This is recommended for the reason that the State Highway Department must carry the Government's portion of the cost for periods of time ranging from thirty days to six months or more. With the limited capital available to the Department this seriously handicaps its operation and the use of the credit of the State represented by other funds lying idle would entirely eliminate this trouble.

CONTACT WITH THE PUBLIC

In road location, construction and maintenance, the public takes a greater interest than in any other governmental activity. Every citizen is an amateur or professional road builder, either active or inactive. As a result no other state activity is so constantly under the scrutiny of the public and taxpayers. It is a healthy sign that a great many do not hesitate to express opinions. In turn, there arises the knowledge that the Department is accountable to the State and to the individuals comprising the electorate. A thing may be proper from the standpoint of engineering and accounting and thus receive official approval, but there may exist in many minds—an unorganized, unofficial section of the body politic—that it should have been done differently. To convince these people has sometimes been a difficult task in the past, but, happily, time has brought about a change.

It has been the constant aim of the Department to seek counsel with those whose interests are affected and to bring to them the benefit of engineering experience and the state-wide outlook on the particular subject or project involved. The result is that today representatives of the Department are welcome visitors at any official or unofficial gathering, and the opinions and advice of those charged with the administration of the law are sought before any important work is planned.

It is gratifying to note that such an understanding exists. The cost of building roads is burdensome, but the public seems to understand that we all have a common interest in doing the work well at the lowest cost. The first enthusiasm, which might have been classed as a degree of hysteria, has passed and the serious proposition of building roads on a business basis has taken its place. We are dealing today in cold figures with a program on which all are agreed. The task would be much harder if we did not have the support and approval of the public. To merit and maintain this confidence is an obligation of which we are not unmindful.

PERSONNEL

(An Appreciation)

The success of any organization depends on the enthusiasm, integrity and industry of its personnel. It is a peculiar fact that there is an inborn desire on the part of many to become attached to a highway organization. This desire is evidenced in the large number of young men who are taking special training in the universities in highway work and the large number of earnest citizens who could do as well or better elsewhere, who seek positions in the nontechnical end of the work. There seems to be a glamour that attracts them. Possibly it gives them the means of putting into effect their ideas of how well the work should be done.

The result is that the Department has been able to select an organization that ranks high in ability and loyalty. Though constant and close supervision is maintained over employees, it has been found that the great majority of employees look to their work in the abstract as their principal guide, and to their superiors more in the light of directors or coordinators of the work. This expresses enthusiasm.

Little complaint has been expressed over assignments to any location or task. Experience shows that other industries have to contend with the personal equation in the less desirable tasks.

Extreme heat and cold, isolation and poor living conditions are factors in construction and maintenance, but men of high type have been obtained who do their work well and cheerfully under these conditions. When we look behind the scenes we discover many things, and to those whose employment under the Department means more than a living no small measure of praise and encouragement is due. Their enthusiasm, loyalty and industry are apparent.

FINANCING OUR STATE HIGHWAYS

THE STORY OF OUR FINANCES—FEDERAL-STATE AND COUNTY—IN THE CONSTRUCTION OF THE STATE HIGHWAY SYSTEM.

"The Bulkhead" Entrance to Wilson Canyon Highway in Lyon County

FLOYD O. BOOE,
Secretary and Auditor

GENERAL FINANCES

Federal Aid.

In the construction of the State Highway System in Nevada, chief reliance financially has, of course, been placed on federal-aid funds which accrue to the State through the various Federal Acts which have been passed extending aid to the States in this form. Without this aid Nevada could never have attempted a program of highway improvement of appreciable extent on account of the sparse population and limited taxable wealth of the State.

The policy of extending federal aid to the States is now well defined and it is probable that this form of financing will remain in effect at least until the full construction of the national seven per cent system. Congress seems to feel the obligation which rests on the Government for the continuance of this program until the Nation is covered with a network of highways. The remarkable increase in the use of the automobile has made the highway problem one of paramount interest to every family, involving as it does consideration of both an economic and social character for each car owner.

Allotments to the States in aid of highway construction from the Federal Government have been very generous, and have been on about a par with the ability of the States to absorb the amounts allotted on the basis of cooperation under the provisions of the various Acts. Undoubtedly it will be the policy of Congress to continue this aid at about the same ratio for some years to come.

The total authorizations to all of the States under the various Federal-Aid Acts have been as follows:

TOTAL FEDERAL AID ALLOTMENTS

1917	$5,000,000.00
1918	10,000,000.00
1919	65,000,000.00
1920	95,000,000.00
1921	100,000,000.00
1922	75,000,000.00
1923	50,000,000.00
1924	65,000,000.00
1925	75,000,000.00
Total	$540,000,000.00

A pending bill now before Congress, and which will undoubtedly be enacted during the present session, provides an additional seventy-five million for each of the years 1926 and 1927, which, together with previous allotments, would give a grand total of $690,000,000. The actual appropriations by Congress of the amounts authorized have followed as closely as cash needs were apparent and to meet actual treasury requirements, although now somewhat behind the total amount covered by the authorizations.

Allotments to Nevada.

The proportion of the total allotment to all the States which is allocated to Nevada is in accordance with the three factors of allotment originally established under the Federal Aid Act. Under these factors Nevada is entitled to receive 1.32870 per cent of each authorization made by Congress.

The amounts allotted to Nevada under the provisions of the various Acts and for the various fiscal years have been as follows:

1917	$64,398.30
1918	128,796.60
1919	836,163.28
1920	1,221,573.57
1921	1,276,344.43
1922	953,436.78
1923	635,624.00
1924	826,410.00
1925	947,623.25
Total	$6,890,370.21
1926, estimated	995,850.00
1927, estimated	995,850.00
Total	$8,882,070.21

Forest Highway Funds.

In addition to the funds allotted to the States for work on the seven per cent system, there has also been authorized large sums for use in road and trail construction within and adjacent to the National Forests. These allotments go almost exclusively to the eleven western States, where most of the forest areas are located, and are divided among the States on a basis of the use and value of the National Forests. These funds are handled entirely by the Forest Service and the Bureau of Public Roads, the States entering into the transaction only to the extent of assisting in outlining the Forest Highway System and making request for the allotment of funds to specific projects. Under the various Forest Highway Fund Acts already enacted, Nevada will benefit in road and highway work to the extent of perhaps one-half million dollars.

National Park Road Funds.

The roads in national parks, which are under the jurisdiction of the Department of the Interior, have been woefully neglected, in spite of the fact that these parks are becoming increasingly popular each year and are accommodating hundreds of thousands of our people each season. As a result of efforts of various public-spirited citizens and associations, extending over a long period of years, the last Congress awoke to the necessity of providing funds for bettering the road conditions in these parks. A bill was passed providing a fund of $7,500,000, to be expended over a period of three years for road improvement within the parks, and under this bill the National Park Service has formulated a plan of improvement for taking up these funds. Although it passed the authorization bill, Congress at the last moment failed to pass the appropriation bill required, so that this measure has had to come up before the present session of Congress. This has meant a delay of one year in placing the actual construction program under way, but it is thought that Congress will make the necessary appropriations and the work can proceed during the year

1925. Nevada is interested in this national park road-work on account of the tourist development of Yosemite and Lassen Volcanic National Parks, both of which are in California, but contiguous to the Nevada line, and to reach them a large percentage of the travel must pass through this State. This is particularly true of the loop travel from Yosemite to the Lake Tahoe region, which enters Nevada over the Tioga Pass south of Minden and passes along the western edge of the State to Lake Tahoe. One of the main routes of travel to the Lassen Park is northward from Reno, through Susanville, and into the east entrance of the park.

New Features in the Federal-Aid Acts.

Since the enactment of the Federal Highway Law of 1921, which first included the principle of the graduated scale of federal aid to the western or public-land States and established the federal-aid seven per cent system, no radical changes have been made in federal-aid policies. A pending bill before the Senate, however, known as the Dowell Bill (H. R. 4971), and which was passed by the House at the June session and is held over as unfinished business of the Senate, does introduce several new features, all of which will be of benefit to the Western States. One of these is the provision whereby the funds for the fiscal year will become available for expenditure on January 1 of that year instead of July 1, the beginning of the fiscal year, as has been the case heretofore. This would serve to speed up the construction program by approximately six months of the States that have been fully absorbing federal funds as rapidly as they become available. This would be the case in Nevada, this State now being in the position of taking up these funds under actual construction as rapidly as they become available.

Another new feature introduced in the pending Dowell Bill is the provision for including the area of nontaxable Indian lands with the area of other public lands in fixing the ratio of privately owned to public lands in the State in arriving at the ratio of federal participation in each of the public-land States. No exact figures are now available as to the effect of this provision on Nevada, but it is estimated that it would increase the Government ratio of participation perhaps 1 per cent. This feature of the bill was introduced at the behest of such States as Oklahoma, and North and South Dakota, within which States there are large areas of Indian land which return no taxes to the States.

The Proposed Colton Bill.

During the session of Congress which adjourned in June, 1924, there was pending before the Road Committee of the House a bill introduced by Representative Colton of Utah, which introduced several new features into the consideration of federal-aid matters, particularly in the eleven Western States. This measure was sponsored by the American Association of State Highway Officials and carries out some suggestions made at the New Orleans convention in 1923 by the Chief of the Bureau of Public Roads.

From the annual report of the Secretary of the American Association of State Highway Officials, just rendered to the annual convention at San Francisco, we take the following extracts relating to the Colton Bill:

The items under this suggested legislation are outlined somewhat as follows:

1. The Colton Bill proper provides that States having a population of less than ten people to the square mile, and more than 5 per cent of their land unappropriated public land or nontaxable Indian reservations, may use their federal funds up to 100 per cent on the primary system until it is completed.

2. That the Bureau of Public Roads may have 3 per cent of the appropriation each year, for not only carrying out the provisions of the Federal Highway Act, as heretofore approved, but also that additional power be given the Secretary of Agriculture to cooperate with other countries bordering upon the territory of the United States, in the construction of international highways.

The reclassification Act, passed by the Congress, makes some substantial changes in salaries that must come out of this fund and it is also readily seen that the heavy increase in mileage of roads constructed will require additional help in federal inspection for maintenance.

3. This section provides that the limitation for federal-aid cooperation which now obtains—$15,000 per mile maximum—shall be increased where construction in mountainous or swampy country on which the average cost per mile for the grading and drainage structures, other than bridges of 20-foot clear span, will exceed $10,000 per mile, and also where, by reason of density of population or character and volume of traffic, the State Highway Department and the Secretary of Agriculture may determine that the road should be improved with a surface of greater width than 18 feet; but in no case shall the Federal cooperation exceed 50 per cent, except in the public-land States.

4. The Association has repeatedly expressed its desire that the funds for construction of roads through and adjacent to the forests be definitely fixed as to their classification and amount. Our last resolution provided that we request that not less than 70 per cent of the appropriations made for forest road construction, exclusive of the first $3,000,000, which shall go to development roads, shall be used for the construction of the Federal-Aid System of Highways through the forests until such system has been completed.

There is very strenuous opposition from the Forest Division of the Department of Agriculture to this proposition. In the hearings held by the Congress, Colonel Greeley made a statement as follows:

"I want to emphasize the fact that the forest roads appropriations are not federal-aid appropriations, the cooperation of the States or the counties is not required as in the case of federal-aid appropriations, the funds are not expended by the State Highway Departments as in the case of the federal-aid appropriations. * * * It would seem to me unwise to limit the discretion of the Secretary of Agriculture in expending the forest highway appropriations. * * * The Secretary of Agriculture should be free to allot from the money that Congress appropriates for the Government to meet its state obligations as the needs arise."

The Chairman: "Is not that true of every department of the Government, that they want a free hand to use it wherever they want it?"

To this Colonel Greeley replied: "I have no doubt that is probably true. * * * I understand that proposals are coming before your committee looking to a change in the legislative features of the Federal Highway Act. * * * One of them is in line with a resolution adopted by a recent convention of state highway officials which asks that 70 per cent of all of the appropriations made under this legislation be allocated exclusively to the seven per cent section where they traverse national forests. * * * In my judgment the best course to pursue is to leave the legislative provisions of the present national highway Act as to forest roads unchanged."

It should be clearly evident to every one that the funds for construction of roads through the forest have reached the present amount due to the fact that in order to construct the Federal-Aid Highway System it is necessary to build some of the roads through the forests. While the forest funds are not handled in the same manner as the regular federal-aid appropriation, they are a part of the fund that is used by the Federal Government in constructing the Federal-Aid Highway System, and it is quite evident that if the funds for forest road construction and development were all the funds needed, the total appropriation for the forest fund would not be nearly so large as it is at present.

5. This section gives authority where it is necessary to build a bridge in territory exclusively owned by the United States, to pay the entire cost (or partial cost, in case the bridge is but partly in Government territory) out of federal funds.

Progress of National Highways Under the Federal Highway Act.

From the report of the Chief of the Bureau of Public Roads for the fiscal year ending June 30, 1924, we quote the following significant paragraphs:

Federal-Aid Road Construction.

A detailed report of the operations of the Bureau in connection with the construction of federal-aid roads is furnished separately for inclusion in the report to Congress which the Secretary is required to make annually by the Federal Highway Act. In this report, therefore, it is believed that such detailed information may be omitted, but it will not be inappropriate, perhaps, to review in a general way the progress that has been made, and to refer to a few of the more significant accomplishments of the year.

It is not difficult this year to single out the most important forward step. The final designation and approval of the Federal-Aid Highway System in all the States of the Union is an event that will be recognized as time goes on as one of the milestones of progress in the improvement of the highways of the country. The map of the system, published November 1, 1923, presents a definite plan for the improvement of the main highways of the Nation—a plan which it is possible to carry out in a period of not more than ten years, and which, in that limited period, will result in a connected system of arterial highways that will permit unobstructed highway transportation between all cities of 5,000 population or larger. The duty of constructing the connecting roads which are needed to give access to the main system rests with the States and counties.

The Federal Highway Act of November 9, 1921, which provided for the designation of the system, also provided that within two years a map should be published showing the progress of selection and designation of the system. The map published within the time limit specified represents the required system practically in its entirety. The determination of the mileage of the system, as prescribed by law, was based on the mileage of all existing roads of record in the several State Highway Departments at the time of the passage of the Act. Each State was asked to certify the mileage of its existing roads according to its records, and the total of certifications amounted to 2,866,061 miles, seven per cent of which, or 200,624 miles, the law provides may be included in the Federal-Aid Highway System.

The map issued in November included 168,881 miles. Subsequently additions were made in several States which increase the total as of June 30, the end of the fiscal year, to 171,687 miles. The original map represents the system of the entire United States on a scale of 1 to 5,000,000. A relatively small edition of it was published for the use of the several state departments and various agencies of the Federal Government. Subsequently, in order to make available a map suitable for more general use, a set of maps consisting of eighteen sheets, each sheet comprising a group of States, was published.

Original System Completed in Three States.

In designating the system in the several States the most important interstate and intercounty roads have been included up to the limit of mileage prescribed by the law, without regard to their state of improvement. A considerable mileage has been included which is already improved, and the magnitude of the task ahead is reduced to that extent.

In three States the original system has already been completed or provided for and, as contemplated by the law, additions to the system in excess of 7 per cent of the total mileage of public highways have been approved by the Secretary as state funds have become available for such extensions. These States are Delaware, Maryland, and Rhode Island. In Delaware the original system, comprising the full 7 per cent of existing total mileage, included 266.84 miles. Completion of this system was recognized by the Secretary on July 17, 1923, at which time the first extensions were approved. In Maryland the original system comprised 1,036.7 miles, and this mileage was completed or provided for and so recognized by the Secretary August 23, 1923, at which time additions were approved. The Rhode Island system of 165.95 miles was reported complete in June, 1924, and acceptance of the system was pending at the close of the fiscal year.

In connection with the completion of the original system in these States it was necessary to consider the condition not only of the federal-aid projects constructed on the approved system, but also all other construction by the State or its political subdivisions. Anticipating the completion of the system in other States, most of which have a much larger mileage, a detailed examination of all roads in the systems of the several States is now under way. The results of the examination are recorded and constitute a complete description of the condition of the entire system. Such descriptions had been completed prior to the close of the fiscal year in Connecticut and Pennsylvania, and were nearly completed in New Jersey. These records will ultimately show in detail the condition of improvement of the entire federal-aid system, and the work of compiling them will be advanced as rapidly as the administration of the Federal Highway Act requires.

As this information is secured it is recorded on road maps of the States on a scale sufficiently large to show the improved sections and the nature of each. These maps, together with written descriptions of each improved section, will furnish the most complete collection of road information that has ever been undertaken.

The Improvement of Through Roads in the West.

The survey of the status of improvement in the Western States indicates that the part of the system in the eleven Pacific and Mountain States, embracing 31,437 miles, is now more than 50 per cent completed. In these States attention has been given especially to the acceleration of the improvement of through roads to the Coast, particularly in Nevada and Utah toward San Francisco. In these States the national need for through east and west connection does not in all cases coincide with the highway needs of the locality. This is a situation which is peculiar to the sparsely settled Western States. Elsewhere it is found that the national and local needs are practically identical.

An extensive investigation of various possible routes across the Mohave Desert in California, Nevada, and Arizona has resulted in the selection of routes which will shorten the line of transcontinental travel by 37 miles. A similar study of the route from Salt Lake City to Los Angeles has made possible a reduction in mileage of 88 miles, and it has been found to be possible to combine these two routes for 103 miles, thus reducing correspondingly the necessary federal-aid mileage.

Progress of Construction.

As the result of the year's work, 8,620 miles have been added to the mileage of completed roads, bringing the total completed since 1916, when the policy of Federal Aid was initiated, to 35,157 miles. Work was in progress at the end of the year on 15,350 miles, and these roads were reported as 56 per cent complete in the aggregate.

The total cost of the roads completed during the year was $144,707,337.26, of which $66,789,426,70 was paid by the Federal Government. The total expenditure of federal-aid funds during the year, including payments made on the completed roads and progress payments on the roads remaining under construction was $79,217,397.90.

STATE FINANCES

The source of funds which can be provided by the State and counties for taking up federal-aid funds and carrying on the work of the Department are now more or less fixed and the policies along this line have become rather well established. These sources of funds and the recommendations which might be made for changes may be briefly discussed as follows:

DIRECT TAXATION (Through the State Levy)—

The State Highway Law, enacted in 1917, provided direct taxation as the main source of funds for state highway construction. This Act levied a state tax of ten cents per hundred dollars, payable to the State Highway Fund, and also a county tax of a similar amount payable to the County-State Highway Fund, all these funds to be under the jurisdiction of the State Highway Department. In addition the Legislature of 1917 made an initial direct appropriation of $40,000 to the State Highway Fund to provide for the establishment of the Department and the beginning of operations prior to the receipt of taxes from the first levy. This same ratio of taxation was continued to the 1921 Session, at which time the state rate, in view of other sources of income, was cut to six cents, which rate has since remained in effect. The county rate for the County-State Highway Fund has remained unchanged except that at the 1923 Session an amendment was passed allowing an optional rate by the county up to the maximum of ten cents, and several of the counties have taken advantage of this provision.

New proposals on taxation which will come up for action at the forthcoming (1925) session of the Legislature will include the entire elimination of the six-cent state rate, an equivalent revenue to be provided through other sources. It is also proposed to entirely eliminate the personal property tax on motor vehicles in view of the tax burden now carried by this class of property through the gasoline tax, the license fees, and federal excise taxes already in effect. Whether or not this proposal is practical remains to be seen, involving as it does the probability of requiring a constitutional amendment. It is certain that this move would meet with popular favor, in view of the fact that a large percentage of the motor vehicles are now escaping the personal property tax. This escaping of taxation is probably due not only to the failure of the Assessors to closely check up on cars, but also partly to the system of licensing and reporting now in effect. Remedial legislation on the subject will undoubtedly be had as soon as possible.

DIRECT TAXATION (Through the County Levy)—

In addition to the direct tax provided in the Highway Act to be levied by the State, the same Act also fixed a maximum levy of ten cents on each hundred dollars valuation of property to be included in the county general levy, the receipts therefrom to be placed in the County-State Highway Fund. This fund could be used only to assist in constructing the State Highway System within the county. Prior to 1923 the amount of this levy was mandatory on all county boards, but the Legislature of 1923 amended the Act to provide that the maximum rate be ten cents per hundred, any rate less than ten cents to be governed by the program of construction annually submitted to each board by the State Highway Engineer. This same amendment also provides that the County-State Highway Fund can be used for maintenance on the state system within the county as well as for construction.

STATE BOND ISSUES—

During the session of 1919, and in line with the plan successfully inaugurated in several other States, Nevada authorized an issue of one million dollars in State Highway Bonds, the issue to be redeemed from the automobile license fees, at the same time establishing an increased fee rate for automobile licenses. During 1920 and 1921 a total of eight hundred thousand dollars of these bonds were issued and sold, practically the entire amount issued being absorbed by the State Permanent School Fund and other state investment funds. When the issue was contemplated, twelve-year serial bonds were authorized and a table of estimated license income for redemption prepared. The actual income from licenses has been far greater during the years 1920 to 1924, inclusive, than was originally estimated, as can be readily seen by a comparison of tables 1 and 2 following, and it is anticipated that the increase of

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TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Various City Paving Projects Carried Through by State Highway Department

Upper left—City of Sparks. Asphaltic concrete pavement.

Upper right—City of Yerington. Cement concrete pavement.

Center—View of Ely, Nevada. Cement concrete pavement laid on Main Street through this city.

Lower left—City of Elko. Subgrade ready for cement concrete pavement.

Lower right—View of Fremont Street in city of Las Vegas on which Willite asphaltic pavement is now being placed.

LAS VEGAS
GARAGE

the actual over the estimated income will be more or less constant to the final maturity date of the bonds in 1930, provided the same fee schedule remains in effect. It is not the intention of the State to issue the remaining two hundred thousand dollars of the issue authorized so long as the present balanced ratio of income and expenditure can be maintained.

TABLE NO. 1

Estimated Bond Redemption

(As Prepared in 1919)

Year	Redemption of principal each year	Interest 6%	Estimated license received each year	*Balance
1920	--------------	$60,000.00	$88,000.00	$28,000.00
1921	--------------	60,000.00	96,800.00	64,800.00
1922	$50,000.00	60,000.00	105,600.00	60,400.00
1923	50,000.00	57,000.00	114,400.00	67,800.00
1924	50,000.00	54,000.00	123,200.00	87,000.00
1925	100,000.00	51,000.00	132,000.00	68,000.00
1926	100,000.00	45,000.00	140,800.00	63,800.00
1927	100,000.00	39,000.00	149,600.00	74,400.00
1928	100,000.00	33,000.00	158,400.00	99,800.00
1929	150,000.00	27,000.00	167,200.00	90,000.00
1930	150,000.00	18,000.00	176,000.00	38,000.00
1931	150,000.00	9,000.00	184,800.00	123,800.00

*This column represents the money remaining in fund after paying principal and interest.

TABLE NO. 2

Estimated Bond Redemption

(As Prepared Nov. 30, 1924)

Year	Redemption of principal each year	Interest payments	Estimated license receipts	Estimated balance available
1920	$90,000.00	$654.15	$103,758.58	
1921	100,000.00	29,126.99	102,410.32	
1922	60,000.00	17,920.48	120,937.73	$29,405.01
1923	--------------	49,000.00	155,000.00	106,000.00
1924	--------------	32,500.00	185,000.00	152,500.00
1925	50,000.00	32,500.00	200,000.00	117,500.00
1926	100,000.00	30,000.00	220,000.00	90,000.00
1927	100,000.00	24,000.00	230,000.00	106,000.00
1928	50,000.00	18,000.00	240,000.00	172,000.00
1929	150,000.00	15,000.00	250,000.00	85,000.00
1930	100,000.00	6,000.00	260,000.00	154,000.00

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

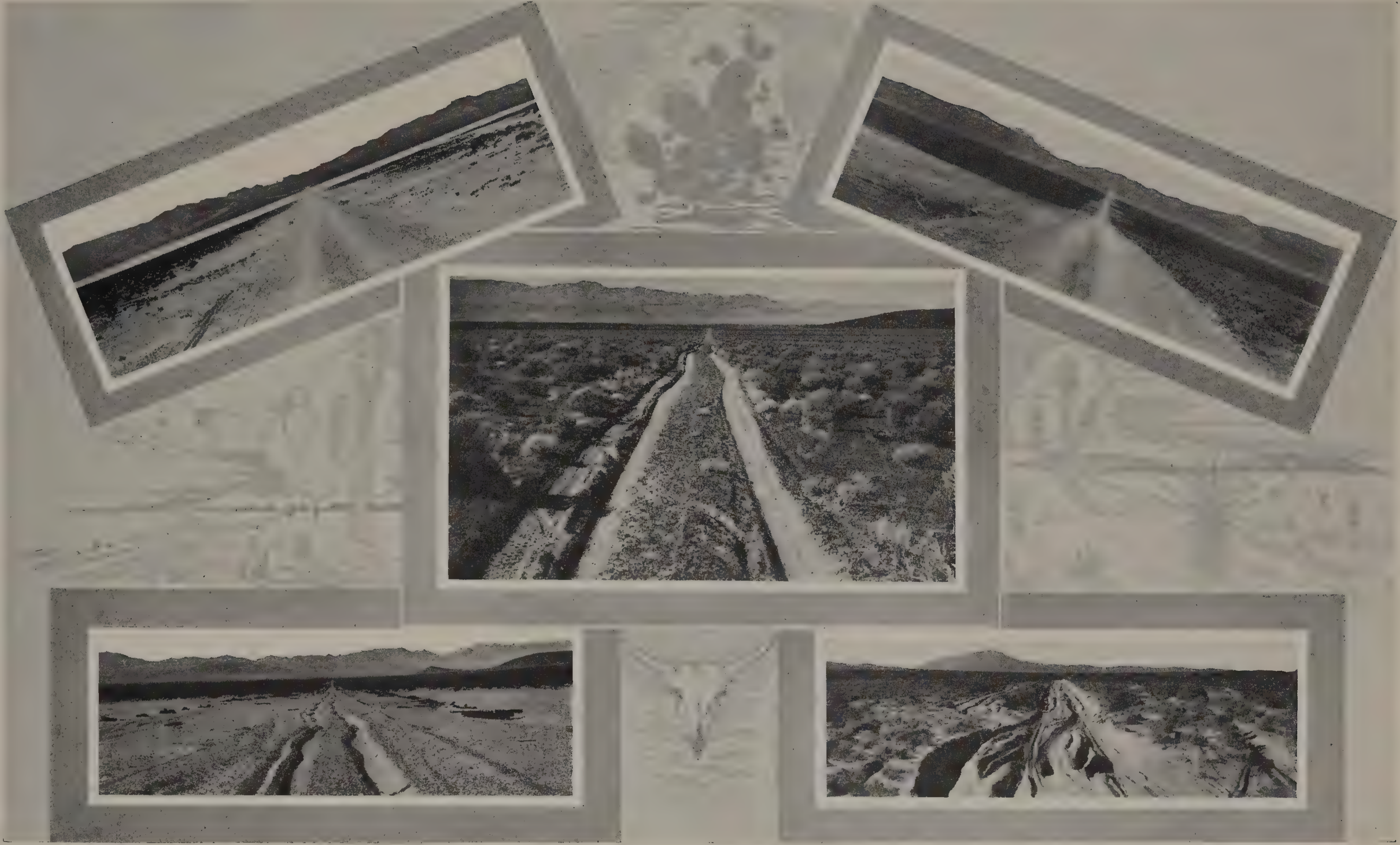
Upper left—Gravel surface highway in Churchill County.

Upper right—Gravel surface highway in White Pine County.

Center—Natural desert road between Goldfield and Beatty. This type of road requires no improvement under existing light traffic.

Lower left—View on the old L. V. & T. grade on the section later improved with an oil-sand surface. This section was impassable before being improved during 1924.

Lower right—"Before improvement" on a section of road between Lovelock and Mill City. This section is now being built as a gravel-surface highway.



AUTOMOBILE LICENSE FEES

Recognized as a proper source of revenue for use in construction and maintenance of state highways is the automobile license fee. The methods of determining the license-fee rate varied in all the States until about six years ago, when it became recognized that the most equitable basis was probably that of vehicle weight inasmuch as the road damage inflicted by the vehicle is in direct proportion to its total weight. Prior to this time the most popular license basis was that of horsepower under the A. L. A. M. rating, under which the small-bore, long-stroke motor in the heavy car was getting by on a lesser fee rate than the ordinary flivver. Some States varied the rate by taking both the horsepower and the factory cost of the car. Even this, however, did not prove satisfactory. Then came the proposition of vehicle weight with a fixed fee rate per hundred pounds, and almost all the States are now licensing on this basis. Nevada adopted the weight basis of licensing in 1919 to become effective in 1920, and the adoption of the rate was a result of the necessity of providing funds for redemption of the State Highway million-dollar bond issue. The fee basis fixed under the Nevada statute is thirty-five cents per hundred pounds of vehicle-weight with the provision that an additional 125 pounds shall be added for each unit of passenger-carrying capacity. Commercial vehicles are rated on the weight plus full capacity-load allowance. Weights used are the factory weights as established by the motor-vehicle manufacturer.

A comparison of the average vehicle fee rate in effect in Nevada with the rates of other States is set forth hereafter. In this connection attention is called to the fact that there has been no increase in the Nevada rate since the enactment of the original Act in 1919, whereas in practically every other State increases have been made every two years under the necessity of providing additional highway revenue.

Average Fees Per Motor Vehicle Based on Gross Registration Receipts, 1923

New Hampshire	$26.36
Oregon	24.52
Connecticut	23.82
Maryland	20.90
Vermont	17.79
New Jersey	17.76
Delaware	17.22
Rhode Island	16.86
West Virginia	16.52
New York	16.49
Minnesota	16.33
Louisiana	16.04
Iowa	15.46
Maine	15.29
Pennsylvania	15.18
North Carolina	15.10
Washington	15.10
Idaho	14.65
Virginia	14.62
Massachusetts	14.53
Michigan	14.37
Kentucky	13.50
Florida	12.92
Arkansas	12.67
Georgia	12.40
Alabama	$12.17
Tennessee	11.82
Nebraska	11.72
Wisconsin	10.84
Oklahoma	10.48
Wyoming	10.40
Mississippi	10.33
Illinois	10.00
Montana	9.88
Nevada	9.80
California	9.64
New Mexico	9.21
Kansas	9.15
Ohio	9.04
South Dakota	8.59
Missouri	8.43
Texas	7.91
Utah	7.23
South Carolina	7.08
North Dakota	6.96
Indiana	6.33
Colorado	5.96
Arizona	5.73
District of Columbia	4.78

The income and distribution of automobile license fees since the first Nevada law became effective in 1913 have been as follows:

INCOME AND DISTRIBUTION OF AUTOMOBILE LICENSE RECEIPTS
January 1, 1913, to December 31, 1924

Year	Amount	Automobile Road Fund	State Highway Fund	Motor-Vehicle License Expense Fund	Auto Road Repair Fund	State Highway Bond Interest and Redemption Fund	Consolidated Bond Interest and Redemption Fund
1913	$3,322.94	$3,322.94					
1914	4,331.08	4,331.08					
1915	7,297.61	7,297.61					
1916	17,721.85	17,721.85					
1917	27,854.65	------------	$22,583.15	$3,332.00	$1,939.50		
1918	34,945.60	------------	28,414.60	4,364.00	2,167.00		
1919	37,110.50	------------	30,738.25	4,661.50	1,710.75		
1920	103,758.58	------------	329.75	5,559.50	2,116.31	$95,753.02	
1921	102,410.32	------------	------------	5,557.00	1,540.85	90,151.55	$5,160.92
1922	108,944.54	------------	------------	5,396.75	1,875.00	------------	101,672,79
1923	155,000.00	------------	96,877.15	------------	------------	------------	58,122.85
1924*	185,000.00	------------	143,000.00	9,000.00	------------	------------	33,000.00
Totals	$787,697.67	$32,673.48	$321,942.90	$37,870.75	$11,349.41	$185,904.57	$197,956.56

*Estimated.

THE GASOLINE TAX

Since the beginning of state highway construction, officials have been endeavoring to devise some plan of taxation of the road-user on an equitable basis to assist in raising the road funds required, and particularly those required for maintenance of the highways after construction. Several years ago some one hit upon the plan of taxing the gasoline used in motor vehicles, and this has since become the most popular and favored form for raising road funds in almost all the States. The plan was first tried in Oregon and Colorado about six years ago, in which States a tax of 1 cent per gallon was imposed. Results in these States were so satisfactory that the rate has since been raised to 3 cents per gallon in Oregon and 2 cents in Colorado, and this tax has gone far towards solving the question of highway revenue in these two States. Since 1919 a majority of the other States have fallen in line, and the gasoline tax is imposed in thirty-six of the forty-eight States. The following table will be of interest as setting forth the popularity of this form of taxation and the increasing rates being established by the States.

A Study of the Rates in Successive Years.

The rate given each year is the highest rate in force that year in each State.

OLD STATES
(Adopting the tax before January 1, 1923)

	1919	*1920*	*1921*	*1922*	*1923*	*1924*
Arizona	..	..	1	1	3	3
Arkansas	..	..	..	3	4	4
Colorado	1	1	1	1	2	2
Connecticut	..	..	1	1	1	1
Florida	..	..	1	1	3	3
Georgia	..	..	..	1	3	3
Kentucky	..	1	1	1	1	3
Louisiana	..	..	..	1	1	2

NEW STATES
(Adopting the tax during the years 1923 and 1924)

	1923	*1924*
Alabama	2	2
California	2	2
Delaware	1	2
Idaho	2	2
Indiana	2	2
Maine	1	1
Missouri	..	2
Nevada	2	2

OLD STATES
(Adopting the tax before January 1, 1923)

	1919	*1920*	*1921*	*1922*	*1923*	*1924*
Maryland	--	--	--	1	1	2
Mississippi	--	--	--	1	1	3
Montana	--	--	1	1	2	2
New Mexico	--	--	1	1	1	1
North Carolina	--	--	1	1	3	3
North Dakota	--	--	--	1	1	1
Oregon	1	1	2	2	3	3
Pennsylvania	--	--	1	1	2	2
South Carolina	--	--	--	2	3	3
South Dakota	--	--	--	1	2	2
Washington	--	--	1	1	1	2

NEW STATES
(Adopting the tax during the years 1923 and 1924)

	1923	*1924*
New Hampshire	1	2
Oklahoma	1	2½
Tennessee	2	2
Texas	1	1
Utah	2½	2½
Vermont	1	1
Virginia	3	3
West Virginia	2	2
Wyoming	1	1

The gasoline tax law of Nevada was passed at the 1923 session of the Legislature and has been in effect since March 20, 1923. The law provides that the income shall be divided—$60,000 to the State Highway Fund and the balance shall go to the road funds of the counties, pro rated on the basis of the number of cars registered in each county. At the time the bill was passed this was estimated as being approximately equal division of the income between the State and counties based on available information. Actually, however, income has been in excess of the estimate so that the counties are getting far more than one-half of the total receipts. Under these conditions the next (1925) session of the Legislature will be asked to amend the law to provide 1 cent to the State and 1 cent to the counties. This would be no more than fair and would carry out the intent of the original framers of the law.

The income from the gasoline tax of two cents per gallon since its effective date on March 20, 1923, to December 31, 1924, by months, has been as follows:

1923	Gallons	Amount	1924	Gallons	Amount
			January	398,714	$7,974.28
			February	445,646.3	8,912.93
March	120,948	$2,418.96	March	515,303.8	10,306.08
April	519,503	10,390.06	April	659,827.8	13,196.56
May	625,490.2	12,509.80	May	795,264.4	15,905.29
June	701,419.5	14,028.39	June	830,379.4	16,607.59
July	772,468.1	15,449.36	July	896,114.1	17,922.29
August	708,586.1	14,171.72	August	856,077.2	17,121.54
September	756,202.1	15,124.04	September	809,599.4	16,191.99
October	648,871.1	12,957.42	October	721,970.7	14,439.41
November	652,793.7	13,055.87	November*	700,000.0	14,000.00
December	542,376.0	10,847.52	December*	700,000.0	14,000.00
Totals	6,048,657.8	$120,953.14	Totals	8,328,897.1	$166,577.96

*Estimated.

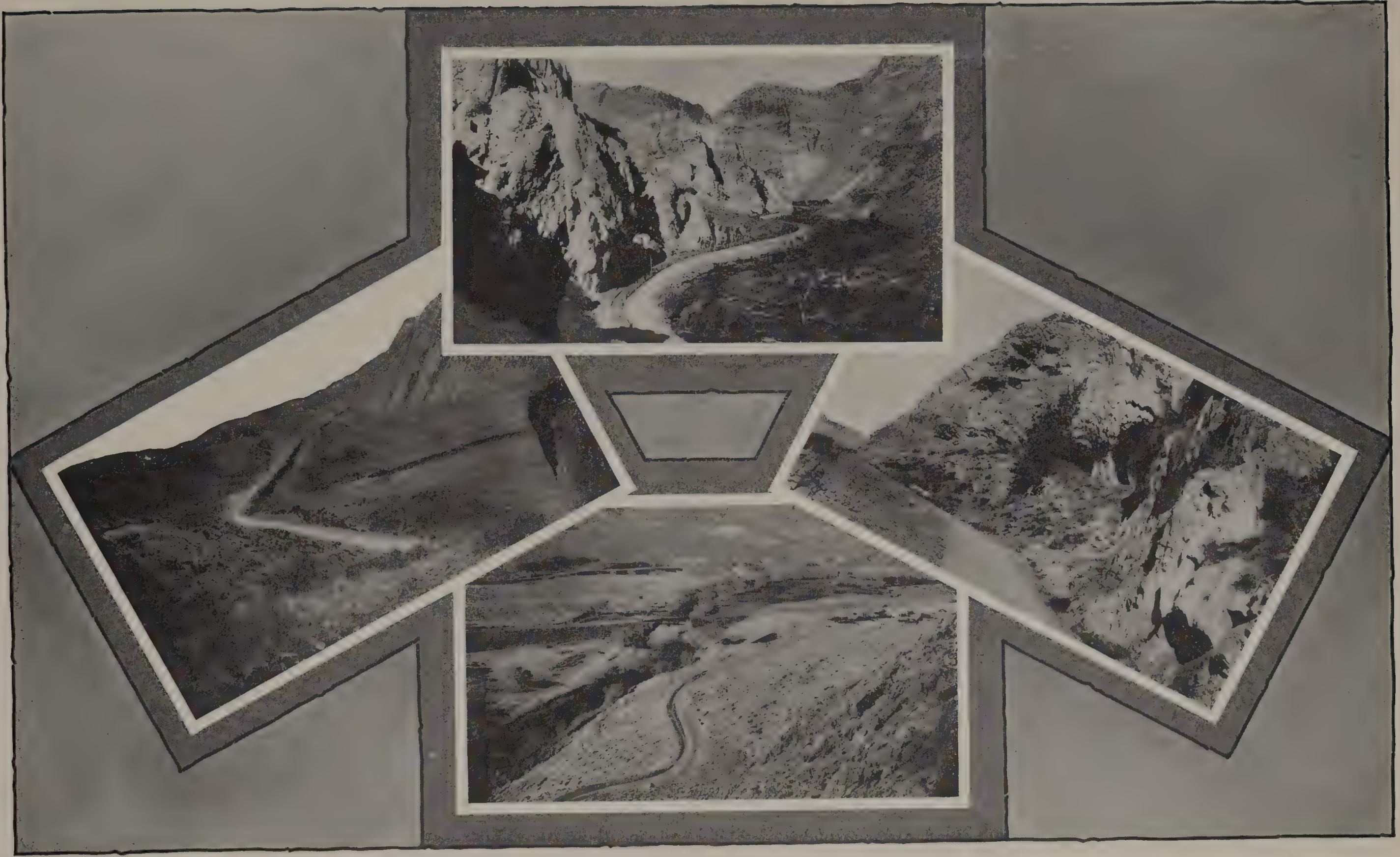
TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Upper—A view of the highway in Wilson Canyon, Lyon County.

Center left—The highway along the Humboldt River between Elko and Carlin in Elko County.

Center right—Highway approaching Cave Rock on the shore of Lake Tahoe, Douglas County.

Lower—The Truckee Canyon near Derby with the new highway grade cutting through the edge of the foothills across the river.



STATE RACING COMMISSION FEES

Under the State Racing Commission Law a pro rata of the total funds handled through the pari-mutuel machines goes to the State Racing Commission. This percentage is now fixed at 8%, and of this 8% the law provides one-sixth shall go to the State Highway Fund. Race meets have been held annually at Reno except during 1924, and the income to the State Highway Fund from this source has amounted to the following:

1917-1918	$17,024.99
1919	7,451.92
1920	20,055.18
1921	11,998.61
1922	20,866.97
1923	23,624.57
Total	$101,022.24

CONTRIBUTIONS FROM OTHER SOURCES

Material financial assistance in highway construction in Nevada has come from outside sources, such as the funds provided by the Lincoln Highway Association to assist in the construction of the Lincoln Highway across Nevada. The total contribution by the Lincoln Highway Association has amounted to $71,426.60, paid by years in the following amounts:

1920	$16,380.00
1921	10,000.00
1922	12,152.99
1923	18,021.14
1924	14,872.47
Total	$71,426.60

In the construction of overhead and underpass railroad structures the railroad companies bear one-third of the cost of the structures. Also in certain cases where several existing grade crossings are eliminated by the construction of the highway over a new location, and entirely eliminating both the existing grade crossing and the need for overhead or underpass structures, the railroad companies are asked to share to some extent in the cost of the new work.

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Projects on Which Lincoln Highway Funds Were Used

Upper—The new highway approaching Eastgate Ranch in Eastgate Canyon, Churchill County.

Second from top—A view of the highway in Little Antelope Pass, White Pine County.

Center—Showing the new highway across Newark Valley in White Pine County, looking toward Illipah.

Lower left—Gravel surface highway across Four Mile Flat in Churchill County.

Lower right—From Antelope Summit towards Eureka, White Pine County.

Contributions from northern California to assist in constructing certain sections or units on Route 1 through Nevada have been promised for several years, and just recently the sum of $5,000 has been received for this work. The total amount promised and under consideration is $50,000.

COUNTY BOND ISSUES FOR HIGHWAYS

At the different sessions of the State Legislature, various bond issues have been authorized as a means of providing funds for assisting in the construction of the State Highway System. In the majority of cases the Act specifies that the funds shall be used only for the purpose of assisting in the construction of the State Highway System within the county, although in one or two cases the expenditures were placed entirely within the discretion of the Board of County Commissioners and the funds largely used on county road work independent of the highway system.

The amounts authorized in the various counties in accordance with these Legislative Acts are set forth in the following table:

NEVADA HIGHWAY BONDS ISSUED BY COUNTIES

(Table Corrected to June 30, 1924)

County	Date issued	Interest rate	Amount of issue	Amount outstanding 6-30-1924	Authorized not sold 6-30-1924	Cash balance on hand
Churchill	1922	$0.06	$21,000.00	$16,000.00		
Churchill	1924	.06	12,000.00	12,000.00	*1919* $67,000.00	
Clark	1920	.06	75,000.00	75,000.00		
Clark	1923	.06	75,000.00	75,000.00	------------	$6,335.72
Douglas	1920	.05½	75,000,00	55,000.00	*1919* 25,000.00	
Douglas	1921	.06	25,000.00	25,000.00		
Humboldt	1923	.06	30,000.00	30,000.00	*1923* 70,000.00	15,500.00
Lander	1923	.06	10,000.00	7,000.00		
Lander	1924	.06	20,000.00	20,000.00		
Lincoln No. 1	1923	.06	50,000.00	50,000.00		
Lincoln No. 2	1923	.06	35,000.00	35,000.00	*1923* 15,000.00	
Lyon	1922	.06	50,000.00	50,000.00		
Mineral	1919	.06	30,000.00	18,000.00		
Washoe	1919	.05½	200,000.00	200,000.00		
Washoe	1920	.06	100,000.00	100,000.00		
Washoe	1921	.06	200,000.00	200,000.00		
White Pine	1922	.06	140,000.00	130,000.00	*1919* 10,000.00	5,946.32
Totals	----------	----------	$1,148,000.00	$1,098,000.00	$187,000.00	$27,782.04

COUNTY ROAD EXPENDITURES

Before the creation of the State Highway Department all road matters were handled, and all expenditures for this purpose were made, by

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TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Upper—Showing heavy work with concrete retaining wall on highway along west shore of Walker Lake, Mineral County.

Center—Showing how highway location must be placed above and in very heavy work where encroachments occur on railroad right-of-way grade. This view is between Vista and Hafed in Washoe County.

Lower—Looking up Keystone Canyon west of Ely. Thirteen dangerous railroad grade crossings were eliminated in this canyon.

the Boards of County Commissioners. The annual expenditures for this purpose were large, particularly during the few years just before and subsequent to 1917, which was the initial year of state highway operation in the State. No exact figures are available covering these expenditures because of the methods of keeping records in the counties, in many cases these expenditures being worded in such manner that it is practically impossible to determine just how the money was used; that is, whether for equipment, for construction or maintenance. In cooperation with the Bureau of Public Roads, however, a survey was made of these county expenditures for the years 1921, 1922, and 1923, and while the information obtained may not be exact, it closely approximates the actual expenditures and will serve as a guide to this class of annual expense which is perhaps larger than is realized by the average citizen. The following tables are submitted showing these expenditures for the three years mentioned, tabulated by counties. Attention is called to the fact that the expenditures set forth represent those made by the counties exclusively on county work, and do not include any sums paid the state on state highway work.

TABLE NO. 1

County Road Expenditures, Calendar Year, 1921

County	Mileage of unimproved roads	Mileage of graded and drained roads	Total road mileage	1921 County road expenditures	Road equipment investment	Total	Miles maintained by county
Churchill	941	139	1,080	$24,561.11	$24,821.54	$49,382.65	150
Clark	667	40	707	17,943.08	10,000.00	27,943.08	40
Douglas	140	13	153	16,277.07	7,863.15	24,140.22	50
Elko	3,685	27	3,712	176,385.37	60,000.00	236,385.37	500
Esmeralda	1,466	----------	1,466	5,621.49	8,200.00	13,821.49	25
Eureka	1,523	----------	1,523	15,435.68	2,000.00	17,435.68	50
Humboldt	1,160	----------	1,160	56,349.39	12,000.00	68,349.39	150
Lander	2,174	----------	2,174	16,361.18	7,500.00	23,861.18	100
Lincoln	1,140	----------	1,140	11,210.00	3,500.00	14,710.00	100
Lyon	461	75	536	36,003.30	20,000.00	56,003.30	75
Mineral	1,238	13	1,251	28,786.86	21,300.00	50,086.86	100
Nye	2,975	----------	2,975	8,349.73	15,000.00	23,349.73	50
Ormsby	73	----------	73	7,178.99	8,000.00	15,178.99	20
Pershing	868	10	878	17,232.72	10,000.00	27,232.72	75
Storey	200	----------	200	3,490.14	3,500.00	6,990.14	25
Washoe	1,635	----------	1,635	52,665.08	50,000.00	102,665.08	200
White Pine	2,367	6	2,373	17,388.56	30,000.00	47,388.56	100
Totals	22,713	323	23,036	$511,239.75	$293,684.69	$804,924.44	1,810

NOTE—The amounts shown as "Road Equipment Investment" in column 6 represents the estimated value of equipment on hand on December 31, 1921, as reported in the County Auditor's reports. No data is available as to whether this includes only the actual inventory value or also includes some expenditures for the year 1921.

TABLE NO. 2

County Road Expenditures, Calendar Year, 1922

County	Balance on hand Jan. 1, 1922	Receipts during 1922	Expended during 1922	Balance on hand Jan. 1, 1923	Road tax rate
Churchill	$12,144.11	$53,664.47	$37,642.61	$28,165.97	$0.06
Clark	6,388.23	27,561.58	27,410.36	6,539.45	.15
Douglas	7,863.15	17,013.06	20,048.92	4,827.29	.34
Elko	37,548.23	104,102.44	95,889.43	45,761.24	.19
Esmeralda	1,055.03	6,271.09	4,458.23	2,867.89	.10
Eureka	8,348.75	15,737.42	15,284.73	8,801.44	.20
Humboldt	17,753.12	32,619.17	41,459.44	8,912.85	.20
Lander	4,634.07	15,365.93	15,000.00	5,000.00	.14
Lincoln	2,140.00	18,360.00	13,613.85	6,886.15	.12
Lyon	27,639,56	34,633.03	45,550.69	16,721.90	.21
Mineral	4,310.25	21,936.37	22,624.48	3,622.14	.30
Nye	6,648.47	27,417.54	24,487.60	9,578.41	.20
Ormsby	5,500.00	12,236.21	12,757.81	4,978.40	.50
Pershing	5,387.82	6,302.81	6,884.46	4,806.17	.15
Storey	1,375.26	5,509.41	6,315.09	569.58	.20
Washoe	27,106.06	71,433.23	70,739.84	24,799.45	.13
White Pine	6,451.88	27,336.70	25,567.73	8,220.85	.26
Totals	$182,293.99	$497,500.46	$485,735.27	$194,059.18	Av.$0.203

TABLE NO. 3

County Road Expenditures, Calendar Year, 1923

County	Balance on hand Jan. 1, 1923	Receipts during 1923	Expended during 1923	Balance on hand Jan. 1, 1924	Road tax rate†
Churchill	$16,021.86	$29,080.14	$29,569.27	$15,532.78	$0.34
Clark	6,539.45	18,940.26	18,940.26	6,539.45	.20
Douglas	4,827.29	15,389.85	18,791.89	8,329.23	.38
Elko	45,761.24	97,661.92	97,568.45	39,992.49	.19
Esmeralda	2,867.89	3,990.63	3,993.56	2,864.96	.10
Eureka	8,801.44	15,821.61	16,706.15	7,916.40	.20
Humboldt	8,912.85	35,695.75	32,661.25	11,947.35	.20
Lander*	5,000.00	10,000.00	10,000.00	5,000.00	.14
Lincoln	6,886.15	9,444.00	10,518.77	7,960.92	.12
Lyon	16,721.90	32,831.59	39,145.38	23,035.69	.32
Mineral	3,622.14	15,658.57	13,713.95	5,566.76	.33
Nye	9,578.41	14,656.42	12,714.11	11,746.12	.20
Ormsby	4,978.40	9,752.85	9,457.57	5,273.68	.50
Pershing	4,806.17	20,931.53	21,812.46	5,687.10	.16
Storey	569.58	6,823.56	7,292.88	11,038.90	.20
Washoe	27,799.45	47,618.44	64,385.14	25,058.39	.13
White Pine	8,220.85	36,446.95	34,484.04	10,183.76	.26
Totals	$181,915.07	$420,744.07	$441,755.13	$193,673.98	Av.$0.215

*Estimated—No report published. †Rate calculated where unreported.

RECOMMENDED POLICIES OF HIGHWAY FINANCE

The report of the Joint Highway Transport Committee of the American Association of State Highway Officials and the National Automobile Chamber of Commerce, just recently off the press, deals in such a broad way with the whole question of highway finance and so treats the matter in the light of the most recent thought that we are pleased to quote from this report certain sections of general interest to every one interested in the question of "highway transport."

The report (in part) is as follows:

Note—"This report is submitted by the Joint Committee on Highway Transport of the American Association of State Highway Officials and the National

Automobile Chamber of Commerce. Since this committee was appointed in 1922 many sessions have been held. Each principle here presented has been the subject of searching scrutiny by the membership of the joint committee and by experts and officials from many fields and public bodies such as the National Tax Association, the Investment Bankers Association, and the American Automobile Association."

PREFACE

A new system of transportation, *Highway Transport*, has been established and is being operated on a vast scale. Its relationship to other forms of transportation and its great utility within its recognized fields have been defined in their major aspects.

With the extensive and universal distribution of the motor vehicle, the general utilization of highway transport with satisfaction and relative economy is dependent upon the mileage of suitable highways. The suitability of highways, in turn, is determined by the adjustment of the public roads to the vehicles, or conversely, the vehicles to the roads. This objective raises at once all the big major problems of highway administration, equitable taxation of real property, public income and expenditures, regulations of motor vehicles and many others. All of these received the earnest consideration of the committee, and this report upon administration and finance is predicated upon the recognition and acceptance of the following general principles of outstanding importance:

Near the Summit of the Kingsbury Grade—the Oldest Road Over the Sierras With Grades Up to 30 Per Cent

1. The public demand for highways is now so great, and the funds involved so large, that it is not possible to meet all demands in a limited period without too great a burden upon the public finance. Therefore, state funds available for new construction should be devoted first to the class of highways of greatest importance to the public under the jurisdiction of the State Highway Department.

2. The sum total of public roads should be considered, for financing pur-

poses, in two major divisions; group one, general-service motor highways, *i. e.*, general traffic flow lines; group two, local-service roads.

3. Notice is taken of the extensive conversion of land that is taking place especially in populous districts, *i. e.*, the changes in the actual or potential utilization of land in which the establishment or availability of motor transport is a major factor by which its value or its potential earning capacity is increased.

4. Notice is also taken of the special benefits which result from extraordinary highway undertakings in congested districts which may properly be financed, in part at least, by the formulation of improvement districts with special assessments. As defined here, this principle is limited to conditions that are not average or normal, and does not apply to rural districts.

It is evident from the above that there are many conditions that will require special consideration. Also, the committee fully recognizes the fact that we have as yet the experience of only a few years available upon which to formulate sound and enduring policies. The situation is not crystallized. One new development succeeds another. It is certain, however, that the following statement of principles records and outlines those policies which have already proven sound, and which at this time embody the best practice.

HIGHWAY FINANCES

1. The highway budget is defined as the total annual expenditures in each State for highway purposes.

2. The annual highway budget should be adjusted to the relative needs for other public purposes.

3. No road should be improved by expenditure of public funds in excess of its earning capacity. The return to the public in the form of economic transportation is the sole measure of the justification for the degree of improvement.

4. Broad surveys made by the United States Bureau of Public Roads have determined conclusively that from 40 to 60 per cent of the average costs of highway construction is expended in permanent improvements, such as grading, draining, structures, engineering and rights of way. Of the remaining cost, all but a small percentage of the surface can be salvaged in reconstruction and constitutes a definite addition to the capital facilities of the community which is passed on to the succeeding generations. From all these studies it thus appears that highway bond issues are justified where the "pay-as-you-go" plan does not promptly provide the highways economically necessary, and where adequate engineering and economic control is assured.

5. The wide variance in the present status of highway development in the several States prevents the adoption of uniform policies for securing the funds necessary for the annual budget. Generally speaking, however, these principles may be set forth:

(a) States in the initial stage of highway development should issue bonds to defer that portion of the annual charge for construction which would overburden either property or the road user.

(b) States where original construction programs are well under way, can, in the main, finance normal new construction from current funds utilizing bond issue funds to defer the cost of special projects.

(c) States where original construction is largely completed are concerned chiefly with maintenance and reconstruction, and should depend on current funds save in cases of emergency.

6. State highway bond issues should be serial in form and should mature over a period not exceeding thirty years.

7. Highway bonds issued by political subdivision of a State should be serial in form and should mature over a period not exceeding twenty years.

8. Serial maturities should be arranged so that the annual requirements of principal and interest will be as nearly uniform as practicable.

9. Sound public financing requires that where motor-vehicle or other special levies are allocated to defray the costs of state highway bond issues, the full taxing power also of the State shall be authorized to guarantee principal and interest in event of failure of such special levies to provide sufficient revenue.

HIGHWAY ADMINISTRATION

1. The large sums involved in highway expenditures and the broad training and experience required in handling them demand that political patronage be eliminated in all highway administration. Stable organizations and policies are essential to the orderly progress of the highway program.

Showing the Effect of Billboards Along the Highways. This is Entering Reno From the East

2. Highways of general motor use in each State should be classified into systems of like importance such as interstate, state and county highways. All others should be classified as local roads.

3. For the purpose of securing uniformity and economy, all expenditures on these systems should be correlated under adequate engineering and economic supervision.

4. The order, kind and extent of improvement for each class and for individual projects in each class should depend upon the relative traffic requirements, present and future.

5. A much larger mileage of highways than at present should be immediately placed under adequate and continuous maintenance and made available for traffic the year 'round.

DISTRIBUTION OF COSTS

1. The cost of building and maintaining adequate systems of highways should be distributed in an equitable relation to the benefits derived. These may be summarized as follows:

A. Benefits to society in general, such as influence on education, recreation, health, fire prevention, police protection, the national defense, the postal service, living and distribution costs.
B. Benefits to definite groups, such as agriculture, manufacture, labor, railroads, mining, forestry, and waterways.
C. Benefits to property served.
D. Benefits to the road user.

2. For the purpose of apportioning costs in relation to benefits received, all highways may be divided into two classes; first, those used by the general motoring public, and, second, those which perform a purely local service function.

Elko County Courthouse, Elko, Nevada

3. Special motor-vehicle taxes should be levied and used only for the improvement and maintenance of highways used by the general public, *i. e.*, for general highway traffic flow lines. They should be expended under the direction of the State Highway Department.

4. The wide variance in valuations, tax burdens, number of motor vehicles in use and the status of highway development in the several States prevents the adoption of any fixed formula as to the proportion of the total costs of highways of general use which should be paid for from motor vehicle funds. Generally speaking, however, these principles may be set forth:

A. In States where the income from motor vehicles is insufficient to meet all of the maintenance costs of highways of general motor use without undue burden to the individual motorist, such funds should be applied first to the maintenance of interstate and state highway systems.

B. In States where the income from motor vehicles is sufficient to meet all maintenance costs of highways of general motor use without undue burden to the individual motorist, any surplus should be used for this class of highway reconstruction and administration costs.

C. In States where the number of motor vehicles will bring in large sums in excess of maintenance without placing undue burdens upon the individual motorist, such surplus should be used to defray all the costs of maintenance and a substantial share of all of the other costs of highways of general motor use.

D. In those States where the motor-vehicle income is more than sufficient to meet maintenance costs of highways of general motor use without undue burden to the individual motorist, it may be found advisable to use such surplus for the purpose of defraying all or part of the costs of bond issues to expedite construction of economically desirable motor highways.

5. Roads of a purely local interest, serving only local needs, should be financed out of local revenues obtained from local general tax revenues. Special assessments on adjoining land to defray a portion of the costs of such roads may be justified.

6. Where extraordinary improvements are undertaken in the vicinity of or serving congested areas of population, the increment, if any, in property valuation following the improvement should be drawn upon to defray an equitable portion of the cost.

FORM OF MOTOR TAXES AND COLLECTION METHODS

1. The motor-vehicle tax should be simple in form and distributed in equitable and just proportion between the different types of motor vehicles.

2. The State should be the sole agency levying special taxes upon the motor vehicle or the highway user.

STATEMENT OF RECEIPTS

Class of income	Paid 1917-1924	Pending	Grand total	Per-centage	Total revenue	Total refunds
Legislative appropriation	$40,000.00		$40,000.00	0.36	$40,000.00	
Taxes, net amount received	1,063,656.27		1,063,656.27	9.45	1,063,656.27	
Automobile license fees	191,796.25	$140,000.00	331,796.25	2.95	331,796.25	
Gasoline tax fees	60,000.00	60,000.00	120,000.00	1.07	120,000.00	
Racing commission fees	101,022.24		101,022.24	.90	101,022.24	
Miscellaneous refunds	8,912.28		8,912.28	.08		$8,912.28
Sales and service (interdepartment)	490,299.93		490,299.93	4.35	490,299.93	
Right of way refunds	6,076.78		6,076.78	.05		6,076.78
State Highway bonds	800,000.00		800,000.00	7.11	800,000.00	
Federal construction refunds	5,266,534.14	376,139.35	5,642,673.49	50.12		5,642,673.49
County construction refunds	2,072,603.12		2,072,603.12	18.41		2,072,603.12
Lincoln Highway Association	71,426.60		71,426.60	.63		71,426.60
City construction refunds	83,219.74		83,219.74	.74		83,219.74
Railroad crossing construction refunds	41,505.52	22,976.78	64,482.30	.58		64,482.30
Special maintenance deposits	2,000.00		2,000.00	.02		2,000.00
Accounts receivable	317,282.16	17,566.67	334,848.83	2.97		334,848.83
Lahontan Plant depreciation	24,397.90		24,397.90	.21	24,397.90	
Totals	$10,640,732.93	$616,682.80	$11,257,415.73	100.00	$2,971,172.59	$8,286,243.14

STATEMENT OF DISBURSEMENTS

Classification	1917 to 1922	1923 to 1924	Total	Percentage
Asset Accounts				
Highway construction	$3, 857, 992.09	$4, 616, 415.35	$8, 474, 407.44	78.15
Surveys, plans and preliminary engineering	286, 381.39	178, 756.35	465, 137.74	4.29
Plant inventories	100,323.55		100, 323.55	.93
Equipment inventory accounts	265,950.45	43,260.29	309, 210.74	2.85
Reno Plant	96, 900.63	175, 459.42	272, 360.05	2.51
Lahontan Plant	19, 798.29	*476.94	19, 321.35	.18
Accounts receivable	191, 267.39	118, 296.68	309, 564.07	2.85
Section 31—Refunds and special transfers	40, 107.17		40, 107.17	.37
Hafed Plant	472.33		472.33	.01
Expense Accounts				
General administration	261, 766.20	171, 704.13	433, 470.33	3.99
Maintenance	185, 646.72	233, 513.47	419, 160.19	3.87
Totals	$5, 306, 606.21	$5, 536, 928.75	$10, 843, 534.96	100.00
To balance—Invested capital			413, 880.77	
Grand total			$11, 257, 415.73	

*Credit.

COMPARISON OF ACTUAL WITH BUDGETED EXPENDITURES, 1923-1924

	1923 Budget	1923 Actual	Increase over budget	Budget saving	1924 Budget	1924 Actual	Increase over budget	Budget saving
Administrative—								
Executive Department	$9,050.00	$9,982.86	$932.86		$9,550.00	$9,680.15	$130.15	
Auditor	18,920.00	17,000.88		$1,919.12	18,450.00	17,340.18		$1,109.82
Field operations	7,000.00	5,496.96		1,503.04	7,000.00	6,930.55		69.45
Public relations		2,159.75	2,159.75		5,000.00	4,865.73		134.27
Executive Engineering Department	11,527.50	9,458.19		2,069.31				
Office expense	6,270.00	5,860.90		409.10				
Special	5,300.00	2,584.94		2.715.06	8,025.00	5,756.32		2,268.68
Building expense	4,300.00	1,133.39		3,166.61	1,650.00	215.95		1,434.05
Miscellaneous	7,500.00	6,033.08		1,466.92	8,200.00	12,032.21	3,832.21	
General office					18,700.00	15,438.60		3,261.40
Police Department and tax collections		2,960.86	2,960.86		7,500.00	11,246.84	3,746.84	
Subtotals	$69,867.50	$62,671.81	$6,053.47	$13,249.16	$84,075.00	$83,506.53	$7,709.20	$8,277.67
Division Offices—								
Division No. 1—Las Vegas	$4,140.00	$4,394.14	$254.14		$5,495.00	$4,367.89		$1,127.11
Division No. 2—Reno	4,497.50	2,138.49		$2,359.01	5,175.00	2,767.07		2,407.93
Division No. 3—Elko	5,780.00	5,647.42		132.58	7,500.00	6,210.78		1,289.22
Subtotals	$14,417.50	$12,180.05	$254.14	$2,491.59	$18,170.00	$13,345.74		$4,824.26
Equipment Division—								
Surplus war material	$10,000.00	*$19,440.78		$29,440.78	$10,000.00	*$4,414.77		$14,414.77
Reno Plant	12,000.00	*6,091.10		18,091.10	10,000.00	7,679.29		2,320.71
General equipment purchased	25,103.76	6,628.10		18,475.66	36,725.00	*672.89		37,397.89
Field Operations—								
Surveys	56,411.00	72,926.25	$16,515.25		58,221.00	32.559.61		25,661.39
Plans and estimates	34,748.50	27,725.47		7,023.03	35,647.00	28,986.61		6,660.39
Rights of way	4,680.00	10,627.52	5,947.52					
Fence construction		1,242.94	1,242.94					
Material surveys		2,039.37	2,039.37					
Bridge design					4,380.00	2,648.58		1,731.42
Maintenance	127,300.00	110,724.87		16,573.13		122,788.60		23,361.40
Nonparticipating totals	$354,528.26	$281,234.50	$32,052.69	$105,346.45		$286,427.30	$7,709.20	$124,649.90
Budget saving				$73,293.76				$116,940.70

COMPARISON OF ACTUAL WITH BUDGETED EXPENDITURES, 1923–1924—*Continued*

	1923 Budget	1923 Actual	Increase over budget	Budget saving	1924 Budget	1924 Actual	Increase over budget	Budget saving
Construction Accounts—								
Contingent progress payments		$1,369,502.76				$2,380,427.85		
Engineer 10% Fund		157,443.52				165,495.51		
Materials by State		219,951.29				53,967.13		
Construction authorities		45,961.88						
Force account projects		112,535.53						
Lahontan Plant		538.06				*1,015.00		
Contingencies						111,129.88		
Subtotals	$2,388,087.44	$1,905,933.04			$2,629,764.12	$2,710,005.37		
Revenue Accounts—								
Accounts receivable		$83,088.96				$35,207.72		
Sales and service credits		124,495.63				110,744.27		
Grand totals	$2,742,615.70	$2,394,752.13			$3,033,132.12	$3,142,384.66		

*Denote credit entries.

THE DEPARTMENTAL BUDGET, 1925-1926

Expenditures

Department	1925	1926
Administrative	$90,430.00	$87,430.00
Division Offices—		
Division No. 1—Las Vegas	$4,918.33	$5,170.20
Division No. 2—Reno	5,175.00	5,175.00
Division No. 3—Elko	7,620.00	7,020.00
Subtotals	$17,713.33	$17,365.20
Field Operations and Engineering—		
Surveys	$32,300.00	$32,300.00
Plans and estimates	32,350.00	32,350.00
Rights of way	7,445.00	7,445.00
Material surveys	2,000.00	2,000.00
Bridge design	4,450.00	4,450.00
Testing department	4,140.00	4,140.00
Subtotals	$82,685.00	$82,685.00
Equipment Accounts—		
General equipment purchased	$43,100.00	$42,100.00
Reno plant	10,000.00	10,000.00
War material	10,000.00	10,000.00
Subtotals	$63,100.00	$62,100.00
Highway maintenance	$230,275.00	$264,100.00
Subtotals	$484,203.33	$513,680.20
Highway construction	$2,500,000.00	$2,500,000.00
Totals	$2,984,203.33	$3,013,680.20

Income

Source of income	1925	1926
Tax levy—6 cents	$120,000.00	
State Racing Commission	20,000.00	$20,000.00
One-cent gasoline tax	85,000.00	90,000.00
Surplus auto license fees	117,000.00	90,000.00
State Highway bonds		150,000.00
Subtotals, State Funds	$342,000.00	$350,000.00
Construction—		
County cooperation	$290,000.00	$290,000.00
City and railroad cooperation	30,000.00	20,000.00
Federal Aid Funds	2,322,203.33	2,353,680.00
Grand totals	$2,984,203.33	$3,013,680.00

PRELIMINARY ENGINEERING

Surveys, Plans, and Estimates
Proper Testing of Materials
Are Required to Secure Federal Aid

The State Must Acquire and Own All Rights of Way

H. F. HOLLEY
Engineer of Surveys and Designs

H. D. MILLS
Right-of-Way Engineer

W. T. HOLCOMB
Testing Engineer

SURVEYS AND PLANS

Conforming to the policy of having surveys and plans approved and the construction program for a given year ready for advertising during the preceding winter or the early spring of the year in which the construction work is to be done, an augmented force, both in the field and in the office, was maintained during the last two years. Six survey parties were in the field during the summer of 1923. These parties were gradually disbanded until on February 1, 1924, but two crews were engaged on location. Another survey party was transferred to the construction department on September 5, 1924, leaving one location party in the field at this time. Two, or possibly three, parties will be required to carry on the future location work.

During the last two years 804.41 miles of highway location were completed by the survey department, of which 605.61 miles have been approved as definite location.

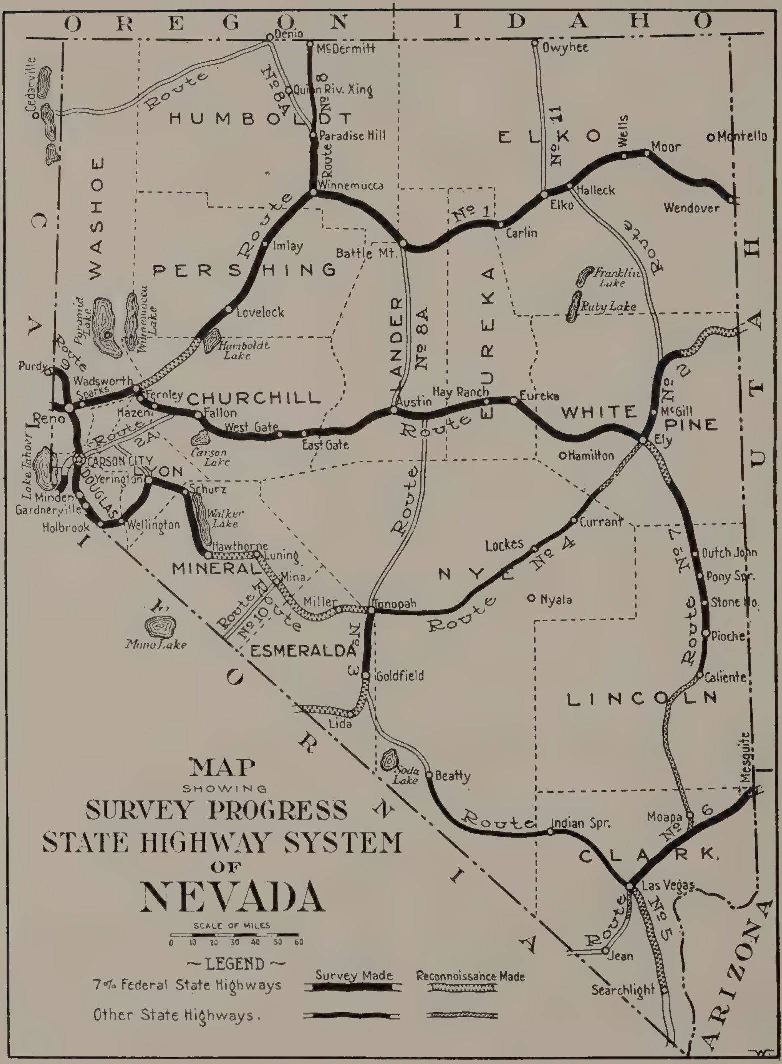
The work of preparing plans and estimates has been standardized as much as possible, full advantage being taken of experience gained in our past work. A great deal of consideration is given to preparing designs upon which the contractors may base economical and balanced bids. As many uncertain elements as possible are eliminated from the plans and specifications, and definite quantities and figures given in lieu of approximations. Especially worthy of mention in this regard is our method of computing and listing the estimate of excavation quantities, which is usually the largest single item of work. Under our system, the excavation estimate shown on the original plans is also the final estimate, and the contractor knows at all times how much work he has done, and the amount of excavation remaining unfinished. Quantities are computed on the basis of actual embankment volume, rather than on the estimated volume of excavation necessary to build the embankment. This method removes forever the bugbears "Shrinkage" and "Swell" with which grading contractors have been gambling, and for which they have allowed liberally in their bids in the past.

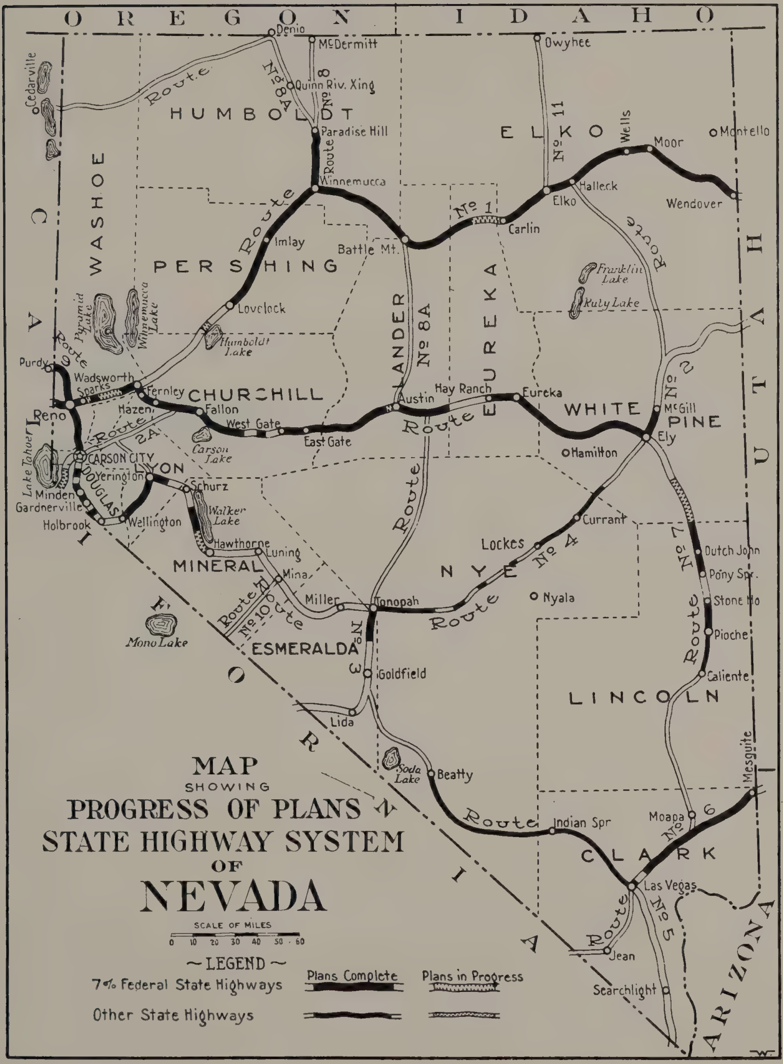
Uncertainty is taken out of the bidding on gravel surface operations by dividing the work into its elements and calling for bids on "Preparing Subgrade," "Loading Gravel," "Hauling Gravel," and "Spreading Gravel." Under this system the Department assumes responsibility for locating and testing the gravel pits, and the contractor's bid prices reflect the fact that he is bidding on an estimate and not on a guess.

These and other practical refinements in design require much additional preliminary engineering work, both in surveys and in preparing the plans and estimates, but the extra expense incurred is negligible when compared with the resulting reductions in construction costs.

During the last two years plans, specifications and estimates have been prepared for 660.57 miles of highway, divided as follows:

Preliminary designs	110.74 miles
Adopted designs	537.78 miles
Highways through incorporated cities	12.05 miles


MAP
SHOWING
SURVEY PROGRESS
STATE HIGHWAY SYSTEM
OF
NEVADA
SCALE OF MILES
0 10 20 30 40 50 60
~ LEGEND ~
Survey Made
Reconnoissance Made
7% Federal State Highways
Other State Highways.
OREGON
IDAHO
UTAH
ARIZONA
CALIFORNIA
HUMBOLDT
ELKO
WASHOE
PERSHING
CHURCHILL
LANDER
EUREKA
WHITE PINE
LYON
DOUGLAS
MINERAL
ESMERALDA
NYE
LINCOLN
CLARK
Denio
McDermitt
Owyhee
Quinn Riv. Xing
Paradise Hill
Winnemucca
Imlay
Battle Mt.
Lovelock
Carlin
Elko
Halleck
Wells
Moor
Montello
Wendover
Cedarville
Purdy
Wadsworth
Sparks
Reno
Fernley
Hazen
Fallon
West Gate
East Gate
Austin
Hay Ranch
Eureka
McGill
Ely
Hamilton
Carson City
Yerington
Minden
Gardnerville
Holbrook
Wellington
Schurz
Hawthorne
Luning
Mina
Miller
Tonopah
Goldfield
Lida
Beatty
Indian Spr.
Las Vegas
Jean
Searchlight
Moapa
Mesquite
Caliente
Pioche
Stone Ho.
Pony Spr.
Dutch John
Currant
Lockes
Nyala
Pyramid Lake
Winnemucca Lake
Humboldt Lake
Carson Lake
Lake Tahoe
Walker Lake
Mono Lake
Soda Lake
Franklin Lake
Ruby Lake
Route No 8
No 8A
Route No 1
Route No 11
Route 9
Route 2A
Route No 8A
Route No 2
Route No 4
Route No 3
Route No 10
Route No 7
Route No 6
Route No 5



MAP
SHOWING
PROGRESS OF PLANS
STATE HIGHWAY SYSTEM
OF
NEVADA

The accompanying maps show the status of surveys and plans on the State Highway System.

BRIDGES

Elsewhere in this report may be found a list of the bridges constructed during the past two years. In addition, plans and estimates have been completed for the following structures to be constructed in the future:

Type	*Length in feet*	*Location*
Concrete and steel undergrade railway crossing	107	Fernley
Concrete and steel undergrade railway crossing	107	Winnemucca
Steel truss	126	Over Truckee River west of Verdi
Steel truss	126	Over Truckee River east of Verdi
Steel-plate girder	75	Over Power Canal at Verdi
Concrete girder	43	Over Simpson Canal near Hoye

Preliminary designs and estimates have also been made for a bridge 200 feet in length over the Truckee River at Wadsworth.

Eight Men Were Killed at One Time on This Death Trap. It will be eliminated by the New Highway Location Down the Truckee River

RIGHTS OF WAY

The State of Nevada, through its Department of Highways, is gradually acquiring title to a great tract of land, comprising approximately 26,000 acres. The land will be 2,700 miles long and but eighty feet in width—a narrow ribbon of terrain indeed, but dedicated to the important purpose of providing a right of way for our state highway system. To date the department has acquired title to 5,250 acres by donation or purchase, and 2,650 acres from the United States—a total of 7,900 acres.

Right of way over privately owned land is acquired in most instances by donation. When it is necessary to cross highly cultivated fields the property owner is paid for the right of way in accordance with the value of the adjoining land, or if he will not accept a fair price for the land taken the right of way is condemned. In the past two years it has been necessary to institute but two condemnation suits. These cases have been disposed of and it is of interest to note that in both cases the court awarded compensation on the offer previously made to the property owner. In eliminating grade-crossings with railroads, and in narrow canyons occupied by a railroad, it is often necessary to locate the proposed highway on right of way granted to the railroad company by Congress. Encroachments on the congressional grant are viewed with great disfavor by the railroad companies, and it is only upon the grounds of topographical necessity that approval can be secured. Maps supporting the request for a lease involving an encroachment must show, in addition to the detailed topography in the vicinity, the full 400-foot width of railroad right of way, with special reference to obstacles standing in the way of railroad expansion. Surveys must be made in great detail. As many as five located lines have been run over the same section before a location was found satisfactory to the railroad company and the Highway Department. When a line has finally been approved in the field by the railroad company's engineer, the preparation of maps and calculation of the description of the right of way involved are started, and in due time the application for a ninety-nine year lease is forwarded to the company for approval.

THE TESTING DEPARTMENT

In order to obtain federal aid in highway construction, it is necessary for the different State Highway Departments to have all materials tested before they are permitted to be used in the work.

The Department of Highways of Nevada has a testing laboratory located in the basement of the Memorial Building at Carson City where it is in constant touch with the headquarters office.

The laboratory is well equipped to make physical tests on practically every kind of material used in construction, with the exception of the compression tests on concrete, and tension on steel. The University of Nevada has in its mechanical laboratory at Reno, one 200,000-lb. capacity Universal testing machine, together with a 100,000-lb. capacity hydraulic compression machine which they allow us to use, so that in this way we are enabled to conduct our steel and concrete tests in Reno without the expense of purchasing large testing machines.

For making chemical tests the laboratory is not so well equipped, and chemical analyses of such materials as water for concrete use, soils, paints, etc., are made for us by S. C. Dinsmore, State Chemist at Reno. Analyses of oils and asphalts for road use are made in our own laboratory.

Conducted as a part of the work of the Testing Department is what is termed a "Material Survey." This is made for each project and consists of a preliminary examination for all possible local materials which may be used in construction. These materials include surfacing gravel, if that particular section of road is to be graveled, and sand, gravel or stone for concrete use. These materials are sampled and submitted to the testing laboratory, where they are examined. If the materials are acceptable, all information regarding them is put in a condensed form and submitted together with the plans to the contractors as they examine the project preparatory to bidding. In this manner much time is saved, and the contractor is given reasonable assurance as to the source of material.

During the last year practically all of the cement and corrugated metal pipe have been tested at the plants by the Bureau of Standards, and in one or two cases of pipe shipments from Salt Lake City the Utah State Highway Department tested the pipe for us, at no expense to us whatever in either case. This system eliminates the possibility of all or a portion of a shipment being rejected after it reaches the job, having to be returned to the factory and replaced by additional pipe or cement which is acceptable. Check tests are being made constantly, however, in the laboratory on the cement and pipe after it has been received by the contractor.

As a result of the investigations in the laboratory the strength of the concrete that has been poured on various projects during the past two years is much higher than that secured during previous years, and we are continually securing better results. The pavement from Reno west toward the state-line was sampled daily by the inspector and tested by the laboratory for compression. Local aggregates were used in this pavement, and compression results average approximately 3,300 pounds per square inch at 28 days in a 1-2-4 mix. In the pavement through the city of Ely (Federal Aid Project No. 70) part of the material was local and the rest was shipped in by the contractor. Frequent sampling of this concrete was made during construction, the average results showing a compression strength of 2,900 pounds per square inch. This also was a 1-2-4 mix. A good part of these results are due to the fact that we are gradually getting away from using a "wet" mix.

The personnel of the testing department includes a testing engineer with one assistant full time and one helper in the laboratory during the summer months. Also, there is the materials surveyor for a few months during the summer. In some instances the testing engineer has been able to make these investigations in the field himself, but this is possible only during the slack season.

The cost of operating the testing department for the two years, 1923–1924, amounted to $14,627.62. This included salaries, travel and auto expense, supplies and equipment. The total construction costs during twenty-three months of those two years amounted to $4,330,779.46. The cost of testing materials, therefore, runs only slightly more than 0.3 of 1 per cent of the total cost of construction.

The following table shows the number and nature of tests conducted by this laboratory, first, during the biennium 1921–1922, and, secondly, for 1923–1924:

Material	*1921–1922*	*1923–1924*
Cement	82	154
Sand for Concrete	68	185
Gravel for Concrete	43	128
Steel	70	192
Corrugated pipe	642	873
Surfacing gravel	256	352
Oils and Asphalt	0	98
Concrete cylinders	210	436
Miscellaneous	8	64
Crushed rock	19	50
Total tests	1,398	2,532

THE BUILDING OF OUR HIGHWAYS

A Brief Summary of the Accomplishments of the Construction Department

Highway Constructed Between Caliente and Pioche,
Lincoln County

HOWARD M. LOY
Assistant State Highway Engineer

CONSTRUCTION PROGRESS

HIGHWAYS

During the 1923–1924 biennium 511.17 miles of completed highway have been added to the improvement of the State Highway System, and an additional 145.66 miles are under contract and should be completed by the summer of 1925. The total mileage of highways complete or under construction at the present time is 915.11 miles. Of the total mileage, complete and under construction, 47.05 miles are surfaced with concrete or asphaltic concrete; 24.01 miles are surfaced with asphalt macadam; 10.16 miles are surfaced with sand and road-oil mixture; 619.06 miles are surfaced with gravel or crushed stone, and 214.83 miles are graded without the addition of surfacing material. Most of the mileage of highway that has been constructed without surfacing is located through material which, in the grading, forms a good wearing surface, and it is estimated that at least 150 miles of the highways of this class will not require surfacing.

Included in the above total mileage are 46.73 miles of highway constructed by the United States Bureau of Public Roads under the Federal Highway Act and paid for from Federal Forest Highway Funds. The forest highway projects so constructed are:

1. On the Ely-Tonopah highway, State Highway Route 4, from Currant to near Barnes.
2. On the Fallon-Ely highway, State Highway Route 2, from Railroad Pass across the Reese River Valley to a point about three miles from Austin.
3. On the same highway, State Highway Route 2, from a point 12 miles east of Austin to a point near the west Eureka County line.

The sand and road-oil section of highway previously mentioned is of special interest. This section is located on the old abandoned grade of the Las Vegas and Tonopah Railroad, beginning at a point about 23 miles south of Beatty and extending 10.16 miles toward Las Vegas. This section of road presented unusual difficulties because of its isolation, the sandy material of which the grade, and in fact the entire stretch of country, is composed, and the absence of a sufficient amount of surfacing material in the vicinity of the project.

Asphaltic road-oil was shipped in tank cars to Carrara, the nearest railroad siding, and there transferred to distributor trucks and hauled to the project. The average haul from the railroad to the job was approximately 19 miles. The oil was uniformly distributed in several applications and mixed with the sand until a thickness of about six inches of thoroughly mixed road oil and sand was produced. This surface was dragged and rolled until well compacted.

This section of road has been a barrier in the past to travel between Las Vegas and the northern part of the State, and the satisfactory surfacing of this sand stretch has opened up an easy route of communication between the northern and southern portions of the State.

The following table shows the progress of construction on road projects:

Mileage Complete and Under Contract

Type of construction	Miles completed 1917-1922	Miles completed 1923-1924	Miles complete to date	Miles under construction	Total miles
Grading only	65.99	133.96	178.37	36.46	214.83
Grading and gravel, shale or rock surface	153.87	346.59	510.23	108.83	619.06
Grading and asphalt macadam surface	3.45	8.75	24.01	----------	24.01
Grading and asphalt concrete surface	1.59	----------	1.59	0.37	1.96
Grading and cement concrete surface	33.38	11.71	45.09	----------	45.09
Road oil-sand surface	----------	10.16	10.16	----------	10.16
Gravel surface, projects previously graded	----------	*9.77			
Asphalt macadam, projects previously graded	----------	*11.81			
Totals	258.28	532.75	769.45	145.66	
Grand total	----------	----------	----------	----------	915.11

*Under column headed "Miles Complete to Date," these miles are included in "Grading and Gravel" and "Grading and Asphalt Macadam" respectively. The miles of "Grading Only" are reduced to correspond.

BRIDGES AND DRAINAGE STRUCTURES

Drainage structures having a span or distance between abutements of more than 20 feet are classified as bridges. Minor structures with spans of twenty feet or less are considered as culverts and are usually included as part of the roadway contract.

During the past biennium, eight major bridges with an aggregate length of 1,405 feet have been constructed in addition to the numerous culverts, dips and other drainage structures. The aggregate length of bridges constructed to date is 3,436 feet or approximately two-thirds of a mile.

The following table shows the number and type of bridges constructed to date:

Bridges of More Than 20 Feet Clear Span

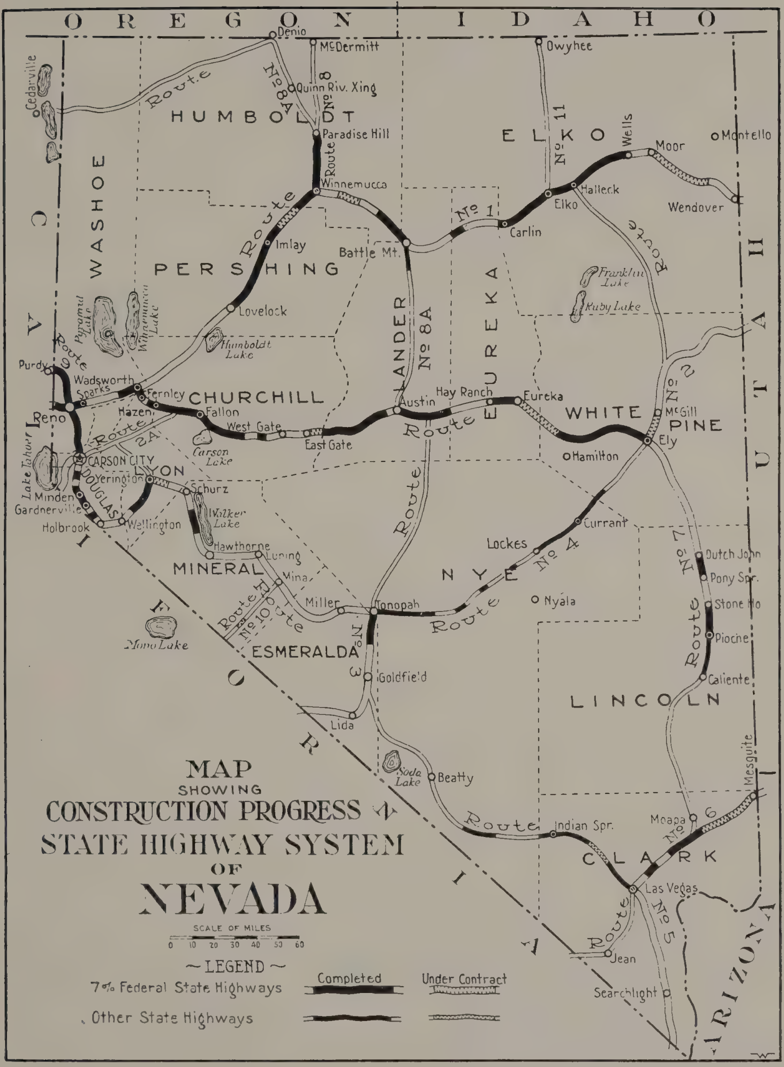
Type of construction	Completed 1917-1922		Completed 1923-1924		Totals	
	No.	Length, ft.	No.	Length, ft.	No.	Length, ft.
Reinforced concrete	8	835	4	228	12	1,063
Structural steel	2	378	1	75	3	453
Timber bridges and trestles	2	818	3	1,102	5	1,920
Totals	12	2,031	8	1,405	20	3,436

Elimination of Railroad Grade Crossings

The elimination of railroad grade crossings is an important problem in the location and construction of highways. This feature of the work is receiving very careful attention in order that these danger spots may be eliminated wherever it is possible to do so.

Forty grade crossings on our state highway system have been eliminated since 1919, either by relocation or grade-separation structures. Six grade crossings have been eliminated by the construction of separation or grade structures. Five of these structures are overhead and one is an undercrossing of the railroad. Two crossings near Lawton's Springs in Washoe County were eliminated by relocating both the road and the railroad. These particular crossings of the Southern Pacific main line were extremely dangerous. The other thirty-two crossings were eliminated by relocation of the road, often with a saving of distance and little if any additional cost.

Following is a list of the structures constructed to eliminate grade crossings. All of these were completed during the year 1924:


MAP
SHOWING
CONSTRUCTION PROGRESS ON
STATE HIGHWAY SYSTEM
OF
NEVADA
SCALE OF MILES
0 10 20 30 40 50 60
~LEGEND~
7% Federal State Highways
Other State Highways
Completed
Under Contract
OREGON
IDAHO
UTAH
ARIZONA
CALIFORNIA
HUMBOLDT
WASHOE
PERSHING
CHURCHILL
LANDER
EUREKA
ELKO
WHITE PINE
NYE
LINCOLN
CLARK
ESMERALDA
MINERAL
LYON
DOUGLAS
Denio
McDermitt
Owyhee
Quinn Riv. Xing
Paradise Hill
Winnemucca
Imlay
Battle Mt.
Lovelock
Carlin
Elko
Halleck
Wells
Moor
Montello
Wendover
Cedarville
Pyramid Lake
Winnemucca Lake
Humboldt Lake
Franklin Lake
Ruby Lake
Purdy
Reno
Wadsworth
Sparks
Fernley
Hazen
Fallon
West Gate
East Gate
Carson Lake
Austin
Hay Ranch
Eureka
McGill
Ely
Hamilton
Carson City
Lake Tahoe
Minden
Gardnerville
Holbrook
Yerington
Schurz
Wellington
Walker Lake
Hawthorne
Luning
Mina
Miller
Tonopah
Lockes
Currant
Nyala
Mono Lake
Goldfield
Lida
Soda Lake
Beatty
Indian Spr.
Las Vegas
Jean
Searchlight
Moapa
Mesquite
Caliente
Pioche
Stone Ho
Pony Spr.
Dutch John
Route No 1
Route No 2
Route 2A
Route No 3
Route No 4
Route No 5
Route No 6
Route No 7
Route No 8
Route No 8A
Route No 9
Route No 10
No 11
Route

Location	*Railroad Crossed*	*Type of Structure*
Rose Creek	Southern Pacific	Concrete and steel overhead
Shoshone	Southern Pacific	Concrete and steel overhead
Deeth	Southern Pacific	Concrete and steel overhead
Wells	Western Pacific	Timber overhead
Ely	Nevada Northern	Concrete and steel overhead
Apex	Union Pacific	Concrete and steel underpass

In the construction of the above structures and also in the shift of the railroad tracks at Lawtons, the railroad company affected paid one-third of the total cost of construction.

The construction program for the future contemplates the elimination of all grade crossings of the State Highway System with main trunk-line railroads. This work is to be done in conjunction with the adjacent road improvements and as rapidly as financial resources will permit.

STATUS OF CONSTRUCTION IN THE VARIOUS COUNTIES

Churchill County

On Route 2 of the State Highway System in Churchill County the following work has been completed or placed under contract during the past biennium:

1.73 miles of grading and gravel surface were completed between the west county line and Hazen, constructed with 8 miles in Lyon county.

1.22 miles of Portland cement concrete pavement completed through the city of Fallon.

5 miles of grading and asphalt macadam surface were completed from Fallon to a point 5 miles south thereof. This project includes a reinforced concrete bridge 42 feet long over the irrigation canal.

5 miles of grading were completed from the south end of the above project to Grimes's Ranch. This project will require surfacing in the near future.

6.35 miles of grading and gravel surface were completed from Grimes's Ranch to Salt Wells.

A gravel wearing surface was placed on 5 miles of the crushed rock base previously laid between Salt Wells and Sand Springs.

11.81 miles of grading, six miles of which is surfaced with gravel, are under construction between Eastgate and the Lander County line at Carrol Summit. This project is practically completed except for

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TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

The Work of Railroad Grade Crossing Elimination

Upper left—Overhead structure under construction over the Nevada Northern Railway in Keystone Canyon west of Ely. The lower left shows this overhead after being completed.

Upper center—The underpass, Union Pacific line, near Apex in Clark County under construction.

Upper right—Elimination of a grade crossing by relocation of the highway alongside the track. This point is between Caliente and Pioche and on this location six grade crossings were eliminated in this manner.

Lower center—The Rose Creek overhead nearing completion. This structure is between Lovelock and Winnemucca on Route 1.

Lower right—The overhead near Deeth under construction. This grade separation eliminated, together with relocation, several very dangerous grade crossings.

about two miles of heavy construction, mostly through solid rock, near Carrol Summit.

The unimproved section between Westgate and Eastgate, a distance of ten miles, should be graded and graveled during the year 1925.

Clark County

On Route 6 between Las Vegas and Mesquite, the following work has been completed or placed under contract during the biennium;

A contract was recently awarded for the construction of an asphaltic concrete surface (Willite Process) on Fremont Street, Las Vegas, and for grading and gravel surface from the corner of Fremont and Main Streets to a point in the existing county road 1,650 feet beyond the north city limits. This project is 1.98 miles long.

8.0 miles of grading and gravel surface were completed, beginning six miles south of Apex and extending two miles north thereof.

At Apex an underpass has been constructed carrying the highway under the tracks of the Union Pacific Railroad. This structure has concrete abutments and a structural steel deck. The highway clearance is eighteen feet in width and fifteen feet in height.

8.2 miles of grading and gravel surface were constructed between a point 2 miles southwest of Dry Lake and Crystal. During the period of construction of this project the Union Pacific Railroad replaced a timber trestle over the highway at Dry Lake with a concrete and steel underpass.

Clark County and the State's maintenance forces have done considerable work on the sections between Las Vegas and the Apex project and between the Apex project and the Dry Lake project, so that a good road exists over these sections.

20.72 miles of grading and gravel surface were constructed between Crystal and the Mormon Mesa near Moapa. This project includes a timber truss bridge 144 feet long over the Muddy River.

16 miles of grading and gravel surface are under construction across the Mormon Mesa, the contract for this work being awarded October 29, 1924.

17.7 miles of grading and gravel surface are under construction between the Mormon Mesa and the Arizona state line near Mesquite.

A timber pile trestle 884 feet long was completed over the Virgin River about eight miles southwest of Bunkerville. In connection with the contract for this trestle, an asphaltic wearing surface was placed on the floor of the bridge previously constructed between Bunkerville and Mesquite. Both of these bridges are within the limits of the above grading project.

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Highway Construction Views

Upper left—Beginning of construction on the overhead crossing at Dunphy, Eureka County.

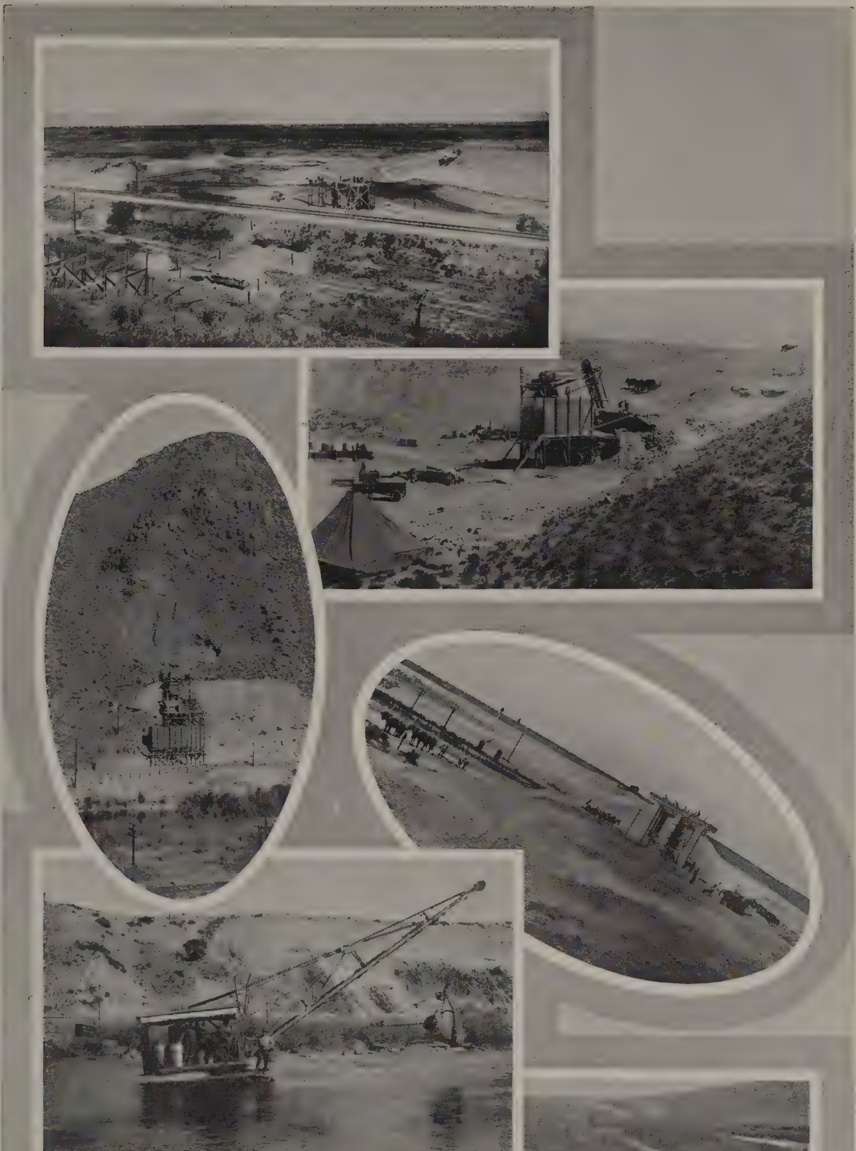
Upper right—A typical gravel screening plant.

Center oval left—The Vista rock-crushing plant.

Center oval right—The concrete overhead at Deeth under way.

Lower left—Making the fill for the track shift near Lawton Springs, Washoe County.

Lower right—Working in the solid rock cut near Lawton Springs, Reno-Verdi highway.



On Route 5 considerable work has been done by State and county cooperation without federal aid. Between the west Clark County line and a point about three miles south of Indian Springs, the old L. V. and T. railroad grade has been regraded and shaped into an excellent earth road. Between the south end of this section and a point near Tule, the railroad grade is located through light silt and has been abandoned for a location to the south and west which, for most of the distance, is in gravelly soil where a good earth road is being constructed. Between Tule and Las Vegas the old railroad grade has been regraded and surfaced with gravel, and a good gravel road constructed.

Douglas County

On Route 3 in Douglas County, 6.69 miles of grading and gravel surface were constructed during the biennium. This project lies between the summit three miles north of Holbrook (Mountain House) and a point two miles north of Carters. We were able to locate an unusually good deposit of surfacing material on this project so that an excellent surface has been constructed which will eliminate the deep mud formerly encountered on this section in the spring of the year.

The Douglas County road forces have improved the road from the southerly end of the above project to the Walker River crossing above Wellington, by regrading, and this section is now a good earth road.

Elko County

On Route 1 in Elko County the following work has been completed or placed under contract during the past biennium:

7.16 miles of grading and gravel surface were constructed between the west Elko County line and Vivian (west end of completed project 5).

1.22 miles of grading and gravel surface and 0.71 miles of cement concrete pavement through the city of Elko were constructed.

20.5 miles of grading and gravel surface were completed between Elko and Halleck.

11.76 miles of grading and gravel surface were constructed between Halleck and Deeth.

A concrete and steel overhead structure was constructed at Deeth to carry the highway over the Southern Pacific railroad tracks.

19.53 miles of grading and gravel surface were constructed between Deeth and Wells. Two bridges were constructed near Deeth in connection with the above project; a reinforced concrete bridge 44 feet long over the Mary's River and a 75-foot steel truss bridge over the Humboldt River.

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Upper right—An improved state highway in Lyon County between Yerington and Smith Valley.

Upper left—A view of the highway on the west shore of Walker Lake.

Center right—Another view of the Walker lake highway.

Lower left—A twenty-mile tangent on Route No. 5, formerly the old L. V. & T. grade in southern Nye County. This is an excellent gravel surface, and machines can travel over this highway at a high rate of speed.

Lower right—Along the highway between Elko and Carlin, Elko County.

A timber overhead structure was constructed at Wells to carry the highway over the Western Pacific tracks.

29.85 miles are under construction between Moor and Silver Zone Pass. About six miles of this project through the Pequop Mountains will not require surfacing under the present contract.

This work should be completed early in 1925.

Esmeralda County

The State and county cooperating have maintained Route 3 of the State Highway System in good condition between the south end of Federal Aid Project No. 11 to the state line near Lida.

Eureka County

On Route 1 the following work has been completed during the biennium:

4.88 miles of grading and gravel surface were completed between the west county line and Dunphy.

A concrete and steel overhead structure was constructed at Shoshone to carry the highway over the Southern Pacific tracks.

On Route 2, 11.15 miles of grading and gravel surface were constructed between Hayranch and Eureka.

10.16 miles of grading and gravel surface are under construction between Eureka and the White Pine County line.

Humboldt County

On Route 8 a gravel surfaced highway was constructed during the biennium from Winnemucca to Paradise Hill, 24.12 miles.

On Route 1 the following work has been completed or placed under construction during the biennium:

13.17 miles of grading and gravel surface were constructed between the Pershing County line and Winnemucca.

A concrete and steel overhead structure was constructed at Rose Creek to carry the highway over the Southern Pacific tracks.

1.12 miles of concrete pavement have been completed in the city of Winnemucca on Routes 1 and 8, and 1.5 miles of gravel surfaced highway is under construction on this same project.

8.47 miles of grading and gravel surface are under construction beginning at Golconda and extending east.

Lander County

On Route 1 the widening and surfacing of project 16 was completed. This project extends from the west Lander County line to Battle Mountain, 8.52 miles.

On Route 8-A, which extends from Battle Mountain to Austin, 9 miles of grading and gravel surfacing were constructed between Battle

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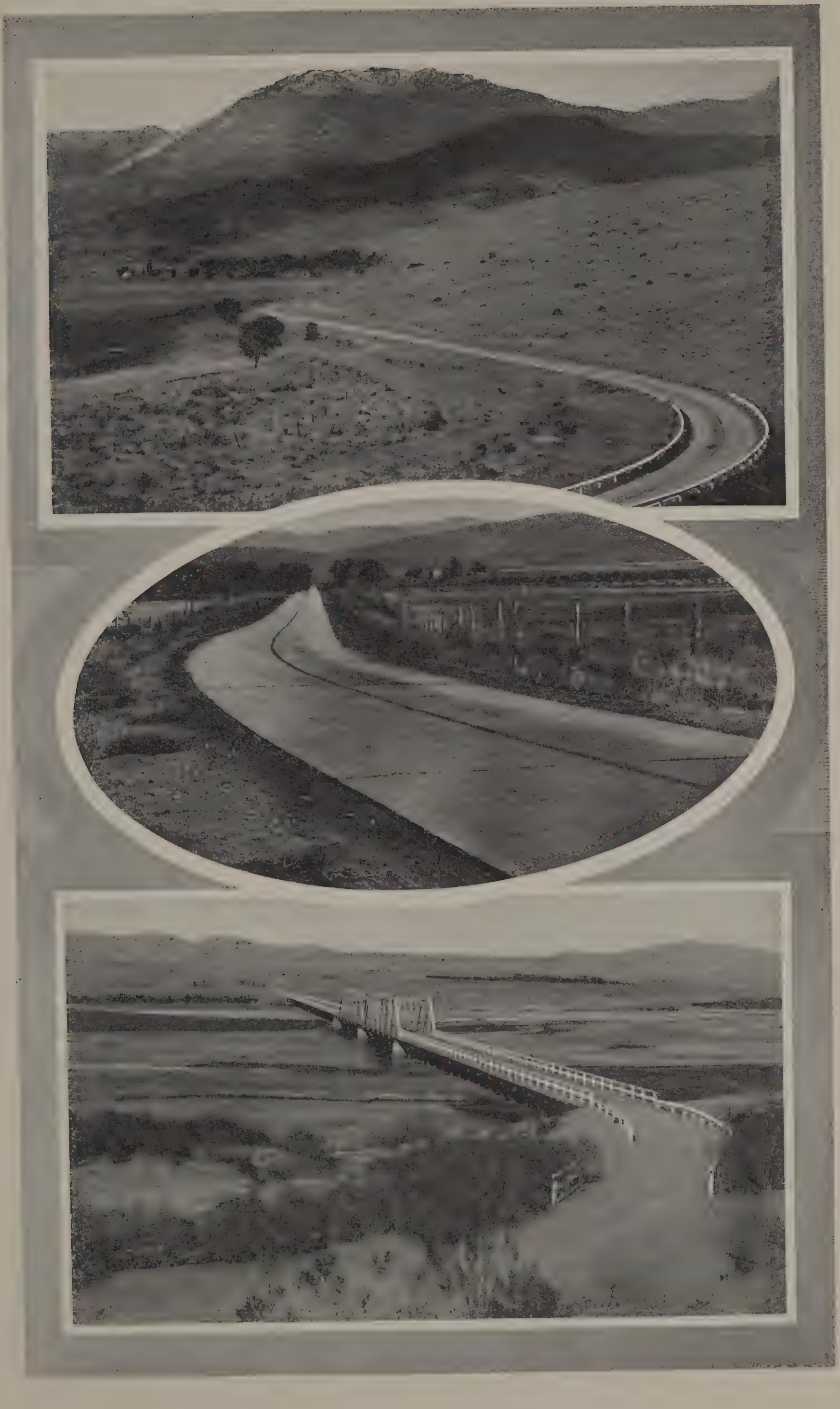
TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Upper—A view of the concrete highway from Washoe Summit. Slide Mountain in the background, Washoe County.

Center—In Pleasant Valley on the Reno-Carson City concrete highway, Washoe County.

Lower—A thousand-foot bridge over the Virgin River near Bunkerville in Clark County.



Mountain and Jenkin's Ranch. This work was done by state and county cooperation without federal aid.

On Route 2 the following work has been completed during the biennium:

5.17 miles of grading, surfaced where necessary, were constructed between the Churchill County line at Carrol Summit and Campbell Creek Ranch.

18.02 miles of grading and gravel surface were constructed between Campbell Creek Ranch and Railroad Pass.

Approximately 17.25 miles of graded highway were constructed by the Bureau of Public Roads with forest highway funds. This project extends from Railroad Pass easterly across the Reese River Valley to the slope below Austin. It is proposed to surface this project with gravel in 1925.

The Bureau of Public Roads has also completed a forest highway project 16.48 miles long extending easterly toward Eureka from the end of the previously constructed project just east of Austin.

The projects west of Austin over Carrol Summit to Eastgate in Churchill County open up an entirely new route for travel and reduces the mileage between Austin and Eastgate about seven miles. There is no more beautiful mountain scenery in the State of Nevada than that along the State Highway Route through Campbell Creek and Eastgate Canyons.

Lincoln County

The following work has been completed on Route 7 during the biennium:

9.56 miles of grading and gravel surface were completed between Dutch John's and Pony Springs.

13.51 miles of graded highway were completed between Stone House and Pioche. 12.41 miles of this project are in good soil and an excellent earth road was secured. It was later necessary to surface the remaining 1.1 miles with mine waste which placed the entire project in excellent condition.

25.11 miles of grading and gravel surface were constructed between Pioche and Caliente.

In connection with the above project a 75-foot timber truss bridge was constructed over the Meadow Valley wash at Caliente.

Lyon County

In the vicinity of Fernley on Routes 1 and 2 the following work has been completed:

From the Washoe County line near Wadsworth through Fernley, the highway has been graded and gravel surfaced; this work being a part of the project from Derby to Fernley. An exception was made in this project across the Southern Pacific right of way just west of Fernley, as an underpass is proposed for the highway under the railroad tracks. The agreements covering this construction have just been executed and work should be under way early in the spring.

A graded and graveled highway was constructed from 3 miles east of Fernley to Hazen, 9.39 miles.

On Route 3, 9.63 miles of grading and gravel surface are under construction beginning at the east city limits of Yerington and extending toward Schurz.

Mineral County

The State and county cooperating have graded the highway, Route 3, between Schurz and the north end of Project 23, and between the south end of this project and Hawthorne, so that a good earth road exists for the entire distance.

In the same manner a portion of Route 10 near Montgomery Pass has been relocated and graded and the road greatly improved.

Nye County

A marked improvement has been made in the condition of Route 4 between Tonopah and Ely during the biennium.

The highway between Tonopah and the Toiyabe Forest boundary, 14.75 miles was widened from fifteen feet as originally graded to twenty-one feet.

The section across the flat just east of Clark's, one mile in length, was graded and graveled.

3.78 miles west of Warm Springs were relocated and graded, an excellent earth road resulting.

8 miles in the silt bottom of the Hot Creek Valley and at "Volcano" have been graded and are being surfaced with gravel.

27 miles were graded and graveled between Locke's Ranch and Currant.

All the above work was done as state and county cooperative projects.

The Bureau of Public Roads constructed approximately thirteen miles of graded highway between Currant and Barnes, White Pine County.

On Route 5, which extends from Goldfield through Beatty to Las Vegas, 10.16 miles of sand and road-oil surface were constructed through the loose sand beginning about thirteen miles south of Carrara and extending toward Las Vegas. In 1923 the only deposit of gravel in the vicinity of the project was opened up and 2¼ miles of the grade were surfaced, but the deposit proved inadequate to complete the entire project. In 1924 the project was completed by constructing a surface composed of road-oil mixed with the sand on the grade and an excellent surface has been produced so that the stretch of sand which formerly required very careful driving in low gear can now be traveled at high speed. The old railroad grade south of the oiled section to the Nye County line is being dragged and surfaced with local material, where necessary, by our maintenance forces, and between the north end of the oiled section and Carrara, where the oil distributor trucks rutted the grade, it is being thoroughly scarified and reshaped. The entire length of Route 5, south of Beatty, should be in good condition for next year's travel.

Ormsby County

No construction work was carried on in Ormsby County during the biennium, as the County-State Highway Fund was obligated for the completion of the highway between Lakeview and Carson City.

Pershing County

13.69 miles of grading and gravel surface are being constructed on Route 1 between Mill City and the Humboldt County line. The contractor has now completed all but 5 miles of this section.

Washoe County

On Route 9, 15.57 miles of asphalt macadam surfaced highway were completed. The grading work was begun in April, 1922, and in September, 1922, the surfacing contract was awarded. The work was entirely completed in October, 1923.

On Route 1, the following work has been completed or placed under construction during the biennium:

5.1 miles of grading are under construction between a point near the California State line in the Truckee Canyon and a point 2 miles east of Verdi. Because of the extremely heavy work near the state line, and the possible necessity of an encroachment on the Southern Pacific right of way, the location of 3,000 feet between the west end of the above construction and the state line has not been decided. This will be constructed in connection with the work now under construction if possible.

8.18 miles were graded and paved with cement concrete between 2 miles east of Verdi and Reno. 2.55 miles at the westerly end of this project are paved nine feet wide on the north side of the road center line, it being our plan to widen this pavement to 18 feet when funds are available. The balance of the project, 5.63 miles, is paved 18 feet wide.

A reinforced concrete girder bridge 52 feet long was constructed over the Highland canal in connection with the above project.

At Lawton, the Southern Pacific tracks were moved over 30 feet through a distance of 2,200 feet to allow room for the highway between the railroad and the steep side hill, thus eliminating two grade crossings. This necessitated constructing a new railroad embankment involving 34,900 cubic yards of excavation and excavating a new channel for the Truckee River, as the new railroad embankment nearly filled the old channel.

8.03 miles of grading and gravel, or selected material surface, were constructed between Derby and Fernley. 5.45 miles of this construction are in Washoe County. It was necessary to omit the construction across the Truckee River at Wadsworth, and for a short distance east of the river, because of a necessary encroachment on the Southern Pacific right of way. This matter has been before the railroad officials for some time but the easements have not yet been secured.

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Upper left—Placing concrete aggregate on Elko City Paving Project, season of 1924.

Upper center circle—Spreading crushed-stone base on asphaltic macadam job south of Fallon. The center lower picture shows the operation of hot asphalt oil-penetration method being spread by the distributor truck.

Upper right—Completed pavement on curve west of Reno on Reno-Verdi highway.

Lower left—Laying cement concrete pavement, City of Winnemucca Project, season of 1924.

Lower right—Completed grade ready for pavement just west of Reno. This highway is over a new location paralleling the Southern Pacific line.

White Pine County

On Route 2 the following work has been completed or placed under construction during the biennium:

13.65 miles of grading and gravel surface are under construction between the Eureka-White Pine County line and Pancake Summit.

23 miles of grading and gravel surface were completed between Pancake Summit and Illipah.

15 miles of grading, 9 miles of which are surfaced with gravel, were completed between Illipah and Robinson Summit.

3.41 miles of grading and gravel surface were completed between Keystone and First and Aultman Streets in the city of Ely. 1.25 miles of this project had been graded but not surfaced prior to 1923. This construction eliminates all of the dangerous grade crossings with the Nevada Northern Railroad in Robinson Canyon. One concrete and steel overhead structure was constructed to carry the highway over the railroad. The other crossings were eliminated by relocation of the highway on the northerly side of the railroad.

0.58 mile of cement concrete pavement was constructed on Aultman Street in the city of Ely.

11.57 miles of grading and gravel surface are under construction between Ely and McGill.

PROPOSED CONSTRUCTION FOR THE 1925-1926 BIENNIUM

Our construction activities since 1919, and especially during the past biennium, have done much to improve the main highways of the State. Many of the very bad stretches of road have been eliminated and replaced by smooth, easy-riding highways.

There are, however, many miles yet to build before our system of good roads will be completed.

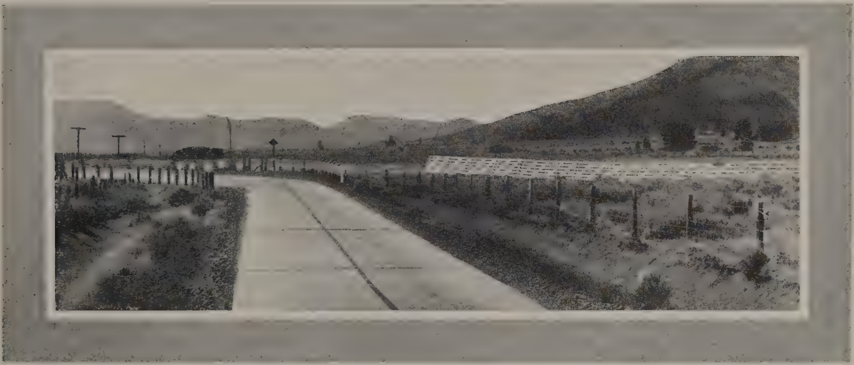
Our construction program for the future contemplates closing the existing gaps and adding to the mileage of improved roads just as rapidly as federal aid and state funds will permit.

Assuming that State and county funds will be available for construction in the same amounts that they have been provided in the past, we propose to place under construction during 1925 and 1926 approximately 250 miles of highway, four major bridges, and at least two grade separation structures.

PERMANENT HIGHWAYS

SECURED ONLY THROUGH CONSTANT MAINTENANCE

Nevada's Policy is Full and Complete Maintenance of All Constructed Projects, Thus Assuring Continuance of Federal Aid Funds



Showing Traffic Division Line, Snow Fences, and Warning Signs for Grade Crossings, between Reno and Carson City

P. L. BONEYSTEELE
Maintenance Engineer

MAINTAINING THE STATE HIGHWAY SYSTEM

GENERAL

The annual cost of maintaining the state's roads after construction is a subject of great general interest. The chief reason for this interest lies in the quite general belief that through the construction of a large mileage of improved highways, the State is piling up for the future an annual maintenance burden quite beyond its ability to pay. Snap judgment on this question has unfortunately been the rule in the past, and without a foundation of facts and figures. In the following pages we will try to set forth the experience of this Department in regard to maintenance costs, and in the light of our experience with this class of expenditure over a period of six years.

We might preface our story with the statement that proper and adequate maintenance of the highways improved is the price of federal aid. The Government has taken a very arbitrary stand in this regard, and has incorporated as a part of the Federal Highway Law the requirement for full and complete maintenance. This maintenance too is subject to regular inspection by the Bureau's Engineers, and must therefore be up to the standard laid down by the Bureau. There is then no chance for the evasion or slighting of maintenance by any State that desires to continue receiving federal-aid funds for highway construction. Our policy from the beginning has been that of adequate and proper maintenance on all constructed projects.

Due to financial limitations and physical conditions in this State, the chief type of road constructed in Nevada necessarily has to be that of the gravel surface. When work was first begun on this type of road, the belief was quite general that it would neither make a very satisfactory road surface nor could it be economically maintained. The foundation for this belief was the experience of the counties in patchwork gravel surface work, wherein attempts were made to secure gravel surface roads without proper drainage and subgrade conditions. Following this the first two years of construction experience of this Department indicated the difficulty of securing a properly compacted gravel surface under the construction contract. All sorts of experiments were tried out, such as requiring sprinkling and rolling, but in spite of this the surface secured, while apparently packed, would soon loosen up. It was found, after two additional years of experimentation, that the only satisfactory manner of securing the compacted surface was to accept the job in loose condition, thus releasing the contractor, and for the State to, under a force account arrangement, secure a properly compacted surface through the following winter season, through the judicious use of road drags and scrapers, and the compacting effect of travel using the road. The surfaces now being obtained under this method are highly satisfactory, are obtained at a minimum of cost, and under proper and constant attention are costing a minimum for maintenance. At first, the expense of compacting the surface was entirely borne by the State as a maintenance expense. This cost ran high on some of the jobs and gave rise to the estimates of maintenance costs ranging from five to seven hundred dollars per mile heard on all sides. For the past four years, however, the item of compacting gravel surface has appeared as a separate unit in the project agreement with the Government, and after the work of compacting was completed and accepted by the representatives of the Bureau the same ratio of the cost was paid by the Bureau as on the balance of the construction.

In the broad consideration of the maintenance problem one very important fact should not be overlooked. That is, that the State is taking over as completed highway each year many miles of road formerly under the maintenance program of the counties, and on which the counties were compelled to spend large sums. Further, that these roads being taken over by the State are almost always the heaviest traffic lanes in each county, and really represent a greater proportionate reduction in county road costs than would be represented by their proportionate mileage. This program should act as a relief of great expense to the counties, and in fact has done so, as can be found by reference to the tables of county road expenditures appearing elsewhere in this report which show a gradual reduction each year.

Maintenance is the means to permanent roads. Many persons fail to make a distinction between high-class pavement and permanent highways, the terms seemingly being synonymous. No highway, however, is permanent, except through constant maintenance and repair. Under this condition of maintenance a gravel surface highway thus becomes as permanent as an adequately maintained concrete road.

Reconstruction.

There comes a time in the life of all highway surfaces when the cost of maintenance of the surface becomes greater than the economic service rendered. This is the point at which reconstruction into a higher type of surface becomes necessary. This condition is usually brought about through traffic increase, it being perfectly apparent that a gravel surface highway, for instance, which under proper maintenance can render adequate and comfortable service to five hundred vehicles per day, cannot render the same service to fifteen hundred vehicles per day. The normal maximum traffic which should be carried by the gravel surface is placed by engineers at approximately five hundred vehicles per day; in excess of that number economy would seem to require the replacement of the surface with a higher type of pavement. Oftentimes the point at which the maintenance problem on a specific project becomes one of reconstruction is not apparent to the layman, but it is the policy of the Nevada Highway Department to give thorough consideration in each case and reach a decision solely on the merits of the case involved.

Maintenance Ogranization.

The Maintenance Department is a separate and complete organization set up within the State Highway Department, under the direction of the Maintenance Engineer. The organization covers the entire State. Field forces consist exclusively of the maintenance patrolmen with their helpers, who are assigned to the patrol and maintenance of definite sections of highway. The patrol system of maintenance has been found by far the most efficient and economical, and this system is used exclusively in the work of the Department. Each patrol section foreman is furnished with the proper equipment for carrying on his work, usually consisting of one truck, one tractor, and several road drags and maintainers. The average patrol section on gravel highways is thirty miles and this can be cared for by a crew of two men. On some long sections it has been found desirable to build a small maintenance house as headquarters for the crew. These houses are usually located at an available water supply and with reference to the most efficient handling of the patrol section.

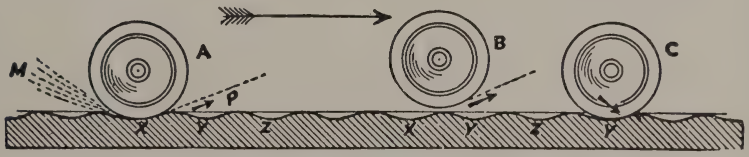
Maintenance Policies.

Certain well-defined maintenance policies have been established by the Department which might be briefly summarized as follows:

1—Maintenance only of roads improved or constructed as highways except in rare cases.
2—Maintenance to begin immediately after completion of the work of surface compacting in the case of gravel roads, and immediately on completion of other types.
3.—Maintenance to be conducted only under the patrol system.

THE MAINTENANCE OF GRAVEL-SURFACE HIGHWAYS

Maintenance Methods and Costs



ILLUSTRATES HOW ROAD CORRUGATIONS DEVELOP

How motor-car wheels make ridges in gravel roads; further description appears in the text.

Corrugations in Gravel Roads.

The big problem in the maintenance of gravel roads is the prevention and the removal of corrugations. The cause of these corrugations has been erroneously attributed to various factors, which, while possible, are not plausible.

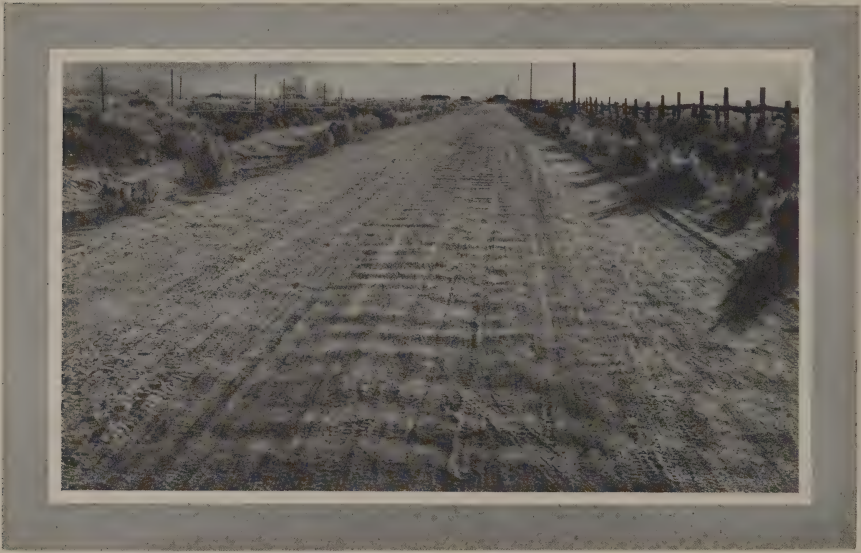
Recent investigations, however, conducted by the United States Bureau of Public Roads disclose the real cause of corrugations in gravel-surfaced and natural roads. These causes are:

1—The kick-back of surface material arising from the spin of the rear wheels of automobiles as they descend after bounce over some obstacle or depression.

2—The impact of both the front and rear wheels of automobiles. "A little investigation will demonstrate the soundness of this explanation. The accompanying diagram shows three positions of the rear wheels of an automobile when traveling over a corrugated road. One little rut 'X' is all that is necessary to start the action. The wheels in position 'A' in order to get out of the rut, must ascend over a little bump. In doing this the friction of the wheel against the surface kicks the binder, or other loose material, out backward in lines marked 'M,' thus making the rut 'X' deeper. In attaining momentum enough to climb the little hill or bump in the direction of arrow 'P,' sufficient momentum is gained to take the wheel clear off the ground for an instant, if the car is traveling rapidly, as in position 'B.' When the wheel again hits the earth, as at position 'C,' the impact causes a slight depression which becomes the rut 'Y,' and, as this descent is made, loose material is again kicked out backward.

"The action thus described repeated again and again, results in a series of ever-deepening ruts, 'X,' 'Y,' and 'Z,' forming the corrugated road surface. As stated in the government report, the front wheels by impact have a tendency to deepen these ruts.

"By watching a car traveling at a fair rate of speed say 25 or 30 miles per hour, on a corrugated road surface, it is easy to see the binder being thrown out from under the rear wheels. And, by looking closely, one may observe just as plainly that at every bump the rear wheels leave the ground."



Preventing the Corrugations.

While it is not possible to totally prevent the formation of corrugations in gravel-surfaced roads, they can be eliminated to a large extent. This can be brought about by the use of small angular-shaped particles of gravel instead of the highly rounded particles for surfacing material.

To provide such a surfacing material in Nevada it is necessary to crush pit-run gravel and to use only the material that ranges in size from one inch down and to reject practically all of the clay and silt occurring as fines in the pit-run material and to retain only those fines produced by crushing. The removal of the clay and the silt from the gravel eliminates one of the greatest contributory factors to the development of corrugations. The setting of the roadway surface is somewhat retarded by the removal of clay, and considerable attention must be devoted to the compaction of the gravel. Eventually, however, a far better and more lasting surface is obtained. The greater portion of the gravel-surfaced roads constructed in Nevada the past two years have been surfaced with crushed gravel and compacted without an appreciable amount of clay or silt. The corrugations are much slower in developing and more easily eliminated by maintenance on these projects than on the other projects where the surface was merely pit-run gravel.

To maintain a comparatively smooth surface on the project constructed of crushed gravel, it is only necessary to drag the surface at regular intervals, regardless of rainfall or other conditions, and to keep a thin covering of loose material brushed over the road by means of drags. The amount of maintenance required depends, of course, largely upon the amount of traffic, for, after a certain volume of traffic dragging will not keep the road free from corrugation. The corrugations can, however, be cut down and the surface materials rearranged and distributed with a road planer. This road planer is a combination of short blades working at opposite angles and a scarifier made up of small teeth that comb and cut down the ridges. The road planer works very satisfactorily on roads where the maximum size of surfacing gravel is not more than one inch in size.

Costs of Gravel-Road Maintenance.

During the year 1923 the Maintenance Department maintained 163.80 miles of gravel roads at a total cost of $47,355.18, an average per unit mile cost of $289.10. During 1924 the mileage of completed gravel-surface highways was increased by 141.30 miles, thus placing under maintenance for 1924 a total of 305.06 miles, which cost $58,746.79. The following table gives a comparison of these costs, and also draws attention to the fact that as the total mileage of improved highways grow, per-mile cost of maintenance will tend to lower because of more efficient and economic maintenance:

	1923		*1924*
Miles maintained	$163.80		$305.06
Total cost	47,355.18		58,746.79
Cost per mile	289.10		192.57
Average cost per mile, 2 years		$226.29	

Cost of Maintaining Concrete Pavement.

The major item of cost in the maintenance of concrete highways in Nevada under the policies of this department is that of shoulder maintenance. Some States do not attempt to maintain a shoulder alongside hard surface roads, preferring to maintain only the slab and when increased traffic warrants additional pavement width, to widen the pavement. Because of financial limitations Nevada cannot do this and, therefore, to fully preserve the investment in the pavement through preventing shattered edges, we maintain the shoulders up to the pavement level, which involves constant surfacing of the shoulder with gravel. During 1923 the segregated costs on our concrete pavement maintenance were as follows:

	Cost per mile	*Per cent*
Building and surfacing shoulders	$244.84	.476
Filling expansion joints and cracks	117.30	.228
Cleaning culverts and ditching	50.45	.098
Cutting weeds	6.32	.012
Repairing guard rail	9.08	.017
Miscellaneous	87.03	.169
Total cost per mile	$515.02	100

Expenditures for concrete highway maintenance during 1923 and 1924 were as follows:

	1923	*1924*
Miles maintained	31.46	42.80
Total cost	$16,202.56	$17,187.15
Cost per mile	515.02	401.57
Average cost per mile, 2 years	$449.63	

Asphaltic Macadam Pavements.

As a type of pavement between the gravel surface and concrete, Nevada has laid two highways of asphaltic macadam pavement, penetration method. These two highways are the Reno-Purdy, sixteen miles in Washoe County, and five miles south of Fallon, in Churchill County. Cost of maintenance on this class of pavement during 1924 was as follows:

Miles maintained	20.56
Total cost	$7,766.57
Cost per mile	377.70
Average	377.70

Selected Material Surfaces.

On certain projects it was found desirable to use a special type of surfacing termed by the Bureau of Public Roads "Selected Material." In most instances this surface consists largely of a limestone formation which packs readily and is susceptible of easy maintenance. A job of this character is that beginning 6 miles south of Yerington and extending to Wilson Canyon. Costs on this type have been as follows:

	1923	*1924*
Miles maintained	7.04	7.04
Total cost	$1,813.04	$1,719.91
Cost per mile	$257.54	$244.30
Average, 2 years	$250.92	

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Upper left—A view of the new highway in the vicinity of Lawton Springs—Reno to Verdi, Washoe County. At this point three lines of track of the Southern Pacific Company were moved out onto a new fill in the river and the highway occupies the railroad grade. One of the most expensive projects ever undertaken by this Department.

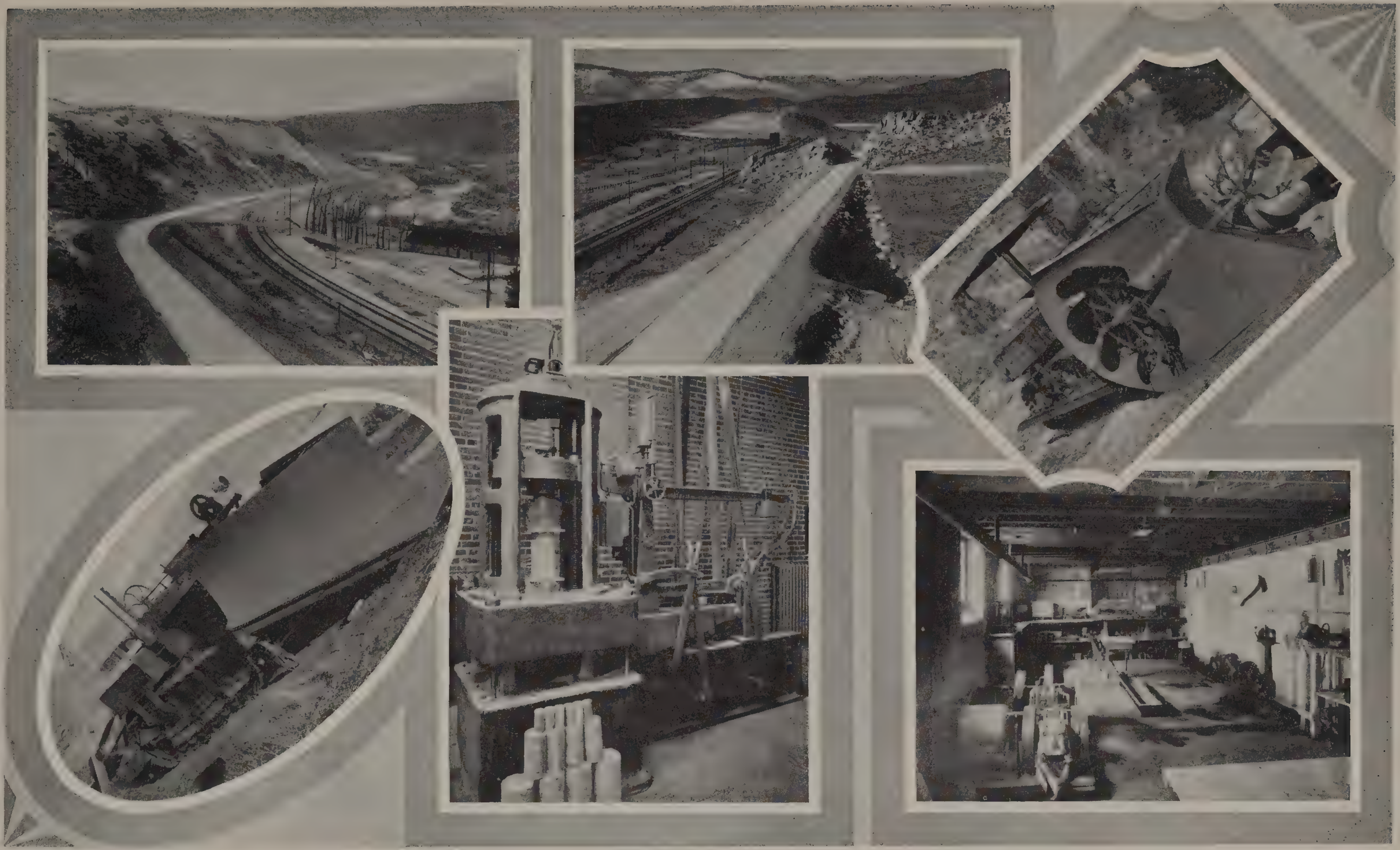
Upper center—View of the Reno-Verdi highway west of Lawton Springs showing heavy solid rock cut.

Upper right—Rotary type snow-plow. The plow was purchased and mounted by the Equipment Division on a military type tractor.

Lower left—View of another type of snow-plow built complete in our shops.

Lower center—Testing machine at University of Nevada used by our Testing Department.

Lower right—Interior view of Department laboratory at the headquarters office in Carson City, Nevada.



Asphaltic Concrete Pavements.

There are one and one-half miles of this type of pavement located through the city of Sparks in Washoe County. No maintenance expenditures were made on this pavement during the year 1924.

Maintenance of Unsurfaced Earth Roads.

There are a number of state highway projects built as an unsurfaced earth type. Usually this is because of the character of material which will stand up reasonably well without gravel surfacing, although frequently short sections of this type of road will become rutted or otherwise in poor condition, in which case gravel surfacing is placed as a maintenance item. Sometimes this maintenance becomes necessary on account of the great increase in travel. On an unsurfaced earth project it is safe to assume that it will become under maintenance a reasonably well surfaced gravel road within a period of about five years. Expenditures on this type for 1923 and 1924 were as follows:

	1923	*1924*
Miles maintained	52.86	66.45
Total cost	$13,240.72	$18,192.65
Cost per mile	250.49	273.78
Average cost per mile, 2 years	$263.46	

SUMMARY OF MAINTENANCE EXPENDITURES 1923 AND 1924

Federal-Aid Project

Class	1923			1924		
	Miles	Total cost	Cost per mile	Miles	Total cost	Cost per mile
Gravel	163.80	$47,355.18	$289.10	305.06	$58,476.79	$192.57
Concrete	31.46	16,202.56	515.02	42.80	17,187.15	401.57
Oil gravel	5.82	9,399.20	1,615.00	5.82	6,300.39	1,082.00
Earth	52.86	13,240.72	250.49	66.45	18,192.65	273.70
Selected material	7.04	1,813.04	257.53	7.04	1,719.79	244.30
Asphalt macadam (under constrn.)	----------	----------	----------	20.56	7,766.57	377.70
Totals	260.98	$88,010.70	$337.33	447.73	$109,643.34	$245.12
Uncompleted Projects (Detours, etc.)						
Earth	24.00	$1,268.92	$52.87	6.00	$1,009.52	$168.25
Snow-Removal Activities						
Concrete	32.00	12,695.38	396.73	28.50	884.53	31.14
County-State Cooperative Projects						
Gravel and earth	126.00	8,749.87	69.40	283.00	11,251.21	39.72
Grand total expenditures	442.98	$110,724.87	----------	765.23	$122,788.60	
Totals budgeted	----------	146,460.00	----------	----------	166,150.00	
Budget savings	----------	$35,735.13	----------	----------	$43,361.40	

Snow Removal.

It has been the policy of the State Highway Department to keep open the paved highways during the winter months, particularly the paved road between Reno and Carson City. Whether or not this expense is economically justified, we cannot say. During a time of heavy storm the public clamors for an open road, and under the pressure of this demand the road has been opened, even though we might not have felt justified in making the expenditure. An expenditure of this sort is entirely governed by weather conditions. For instance, during the winter of 1922–1923 heavy storms prevailed, and a total expenditure of $396.73 per mile was made to keep the highway open, whereas during 1923–1924 no heavy storms occurred and the expense was only $31.14 per mile. During the present season of 1924–1925 the Department is prepared to keep the highway open as a part of the service in connection with the 1925 Legislature session, and for this work the following equipment is on hand: One Rotary type snow-plow, one railroad type snow-plow, two "V" type snow-plows, five trucks (Heavy Duty) and two tractors.

In snow-removal work, the ordinary road grader has been found entirely unsatisfactory when the snow is greater than one foot in depth. The special type of plows built in our own shops have proven very satisfactory, however, and with them we have been able to keep the road open with a minimum of effort and expense.

Comparative Maintenance Costs.

As a closing part of the story of state highway maintenance in Nevada we quote from a recent issue of the *Nevada Highway News* an article prepared by the Maintenance Engineer of the Minnesota State Highway Department concerning the comparative costs of maintenance on various types of roads:

> Comparative costs of maintenance of various types of roads are actually meaningless, at the present time, because as yet we have not been able to find a unit of comparison, or of measure, in which it is possible to express such comparative costs with any degree of practicability.
>
> It is of course universally understood that the cost of maintenance is affected by varying volume and weight of traffic, and that first thought is naturally that the "per-ton mile" is a suitable unit of measure. On going further, however, you begin to discover that this is not such a natural unit as at first appeared.
>
> ### WHY THE TON-MILE UNIT IS UNSATISFACTORY
>
> For instance, it has been found in the various tests, which have been carried on by the Highway Department of Illinois, the Bureau of Public Roads, and others, that traffic consisting of Ford automobiles can evidently be carried on an ordinary concrete pavement in unlimited volume and for an unlimited time with no appreciable effect on the slab. Under such traffic the ton-mile capacity of a concrete pavement is practically unlimited, so far as effects from such

traffic are concerned, with corresponding absence of maintenance costs due to traffic.

If, however, the traffic consists of heavy loads such as are usually common to the larger trucks, it is found that the ton-mile capacity of the same pavement is very much less; in fact, that it may be decidedly limited under this kind of traffic, and naturally the unit maintenance costs make a corresponding jump under those conditions. It is therefore evident that, in order to make an intelligent study of maintenance costs, it is not sufficient to refer to the volume and tonnage of the traffic, but that it is necessary to consider the actual individual loadings or groups of loadings. So far as I know, there has been proposed up to this time no suitable unit or units of measure, which appears practicable. In fact, the committee on maintenance of the American Association of State Highway Officials, when encountering this problem at its last meeting, was not able to find a suitable unit and in its recommendations asked for help along that line.

Maintenance costs and traffic capacity are of course also affected by other factors, both physical and climatic, some of which may develop to be as complicated as the traffic factor, but I feel safe in saying that these factors may be considered as comparatively simple, and the costs and capacity due to these factors do not vary very widely on roads of the same type, and even on roads of different types. Such items as the maintenance of the subgrade, right of way, and waterways, are practically constant.

The difficulties so encountered in studying maintenance costs and traffic capacity of pavements have not been so apparent on gravel and dirt roads, simply for the reason that the traffic capacity of these roads is comparatively limited. However, the traffic capacity of gravel, and even more so of dirt, roads is greatly affected by weather and climatic conditions, which also complicates the matter.

Although we have taken traffic counts in Minnesota for a number of years at a large number of points on our trunk highway system, and which information so gathered has proven of great help in planning the construction program, I must confess that, while frequently they explain the reason for the apparently high maintenance costs on some particular road, they have not been sufficiently detailed or extensive as a traffic survey to make possible such a detailed study as it now begins to appear will eventually be necessary. In fact, the change in the character as well as in the volume of traffic in recent years has been so great that a more detailed survey in the past would probably not have been of any material value at this time. It would have shown the increase and change in traffic.

Some Figures

Although comparative cost figures are of doubtful value, we may nevertheless study the expenditures with great interest, and herewith are some of the outstanding figures, taken from the cost analysis of the maintenance expenditures of the Trunk Highway System during the past year.

The expenditures on dirt roads average $375.16 per mile, of which 73 per cent was for maintenance proper, 16.1 per cent for betterments, 5.7 per cent for special work such as marking, etc., and 5.2 per cent for overhead and supervision. The highest cost per mile was $1,496.45 on a road which was practically entirely reconstructed; therefore, three-quarters of this figure actually represents the betterment.

The expenditures on graveled roads averaged $540.97 per mile on the older graveled roads and $538.46 per mile on the more recently constructed graveled roads. Of these amounts 83.6 per cent was for maintenance proper, 5.2 per cent for betterments, 6 per cent for special work, and 5.2 per cent for overhead and supervision. The highest cost per mile on any one graveled road was $2,745.17, practically all of which can be classed as maintenance proper in this particular case.

In the expenditures on concrete roads, we find a wide variation between those made during the first year after construction and those made on older pavements. The average per mile on first-year pavements was $360.55, whereas the average per mile on the older pavements was $169.55. The difference is found to be almost entirely for repairs found necessary on the newly constructed shoulders.

Of the expenditures on concrete pavements 9 per cent was for maintenance of the slab proper, 64.6 per cent for shoulder-and-drainage maintenance, 4 per cent for betterments, 16.5 per cent for special work, and 5.9 per cent for overhead. Patches and filling cracks account for $32.40 per mile. Repairs to shoulders account for $243 per mile on the new roads and $65 per mile on the older roads. Work on structures account for $25.30 on the new roads and $13.30 on the older roads. The balance comes under special work, the largest item of which was $25.30 for snow-drift prevention, and $16.20 for markers, signs, and warning signals.

It may be interesting to know that of the $3,253,890.52 expended during 1923 on the trunk highways by the maintenance organization the State Highway Department, making an average expenditure of $465 per mile, 60.7 per cent may be classed as for maintenance proper, 15 per cent as for betterments, 8.7 per cent for special work, such as marking signs, snow-drift prevention (which can hardly be classified as maintenance proper), and 5.6 per cent for overhead supervision, including the operation of the district offices and the central office. Analyzing these expenditures, we find that 74.6 per cent went for labor of various kinds, 9.6 per cent for material, and 15.8 per cent for operation of equipment.

Although as explained before the "per-ton-mile" is of no actual practical value as a unit in comparing maintenance costs, nevertheless an application of this unit is interesting. For instance on Trunk Highway No. 3, between Elk River and Big Lake, which is paved with concrete which, it is estimated, carried 937,000 gross tons during the past year, the cost of maintenance was $0.165 per thousand ton miles (about 1/100 cent per ton-mile) whereas on Trunk Highway No. 1 between Hugo and Forest Lake, which is a gravel road attempting to carry traffic far beyond its capacity, and which it is estimated carried 872,200 gross tons during the past year, the cost of maintenance was $3.15 per thousand ton miles (about 1/3 cent per ton-mile).

As the estimate of the gross tonnage includes the weight of vehicles as well as the loads, it is possibly reasonable to assume that the cost per net ton transported is about again as large as the above figures.

THE EQUIPMENT DIVISION

As a necessary part of the operations carried on by the State Highway Department there has been established at Reno an equipment headquarters or depot. At this depot there are located the necessary machine-shop facilities for the proper repair of the large amount of equipment owned by the State, as well as proper facilities being provided for the storage and handling of the equipment. The chief function of the Equipment Division has been that of receiving, repairing, storing, and distributing the large quantities of surplus war material allotted to the State under the various Congressional Acts disposing of this surplus equipment. During the past two years the Department has found it desirable to purchase several large units of equipment required for special heavy work, and it is the duty of the Equipment Division to receive this equipment, place it in operating condition, and keep it in repair after use has begun.

The amount of surplus war material received has been gradually decreasing during the past two years, so that at the present time the only material being received consists almost exclusively of small tools for shop use, with small quantities of motor parts and miscellaneous tools. Bills now pending before Congress provide for the distribution of a large number of additional trucks, cars and tractors now being held in reserve by the War Department, and should these bills pass this State would receive quite an assortment of motor vehicles, all of them probably being in good condition. The State's policy of distributing the surplus war material among the counties and cities for road-building purposes has been of great assistance to these political subdivisions, and has saved them large sums of money in the outright purchase of similar equipment. In this distribution the State has been as generous as possible, and has reserved only such equipment as is actually required for its own needs. The cost of the equipment to the cities and counties has been very nominal, equaling only the cost of freight and handling charges, which in most instances is equivalent to about 10 per cent of the original cost value. The facilities of the machine shop have been largely used in the building of special equipment through the use of a combination of surplus war-material units and other units purchased. This is particularly true of such items of equipment as snow-plows, derricks, asphaltic oil-pressure distributors, dump-body trucks, etc. Large fleets of dump-body trucks have been turned out for the use of the Maintenance Department through utilizing the truck unit received as surplus war material and mounting on same a steel dump body with hydraulic hoist. The truck unit probably cost in freight three to five hundred dollars, the dump body and hoist four or five hundred additional. With the addition of labor costs the unit when complete represents an outlay of possibly twelve hundred dollars for an equipment unit that would in the open market cost from four to six thousand dollars. Most of the trucks received and thus equipped were new and unused, with the exception of being somewhat weathered due to the poor storage provided by the Army authorities during the time the equipment was in their possession.

An effort has been made to salvage the valuable parts of the motor equipment that is no longer suitable for the purpose for which it was originally manufactured, and to assemble these salvaged parts into

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TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Views in the Equipment Yard

Upper—The Shop Building.

Center—Interior view of Shop Building.

Lower—Another Interior View of Machine Shop showing Snow-Plow Built by the Department under construction.

units needed on construction work. Five portable power units ranging from 10 horsepower to 70 horsepower have been assembled from the salvaged parts.

With the decrease in the amount of "Surplus War Equipment" allotted to this State there has been a corresponding decrease in the amount transferred to cities, counties, and other road-building agencies.

New construction at the Reno plant includes the addition of a permanent toolroom to the machine shop and the installation of a steam heating-plant. The plan previously proposed of making permanent structures out of the hangars by covering them with corrugated iron has not been followed out. Instead, the hangars are being recovered with canvas from our surplus war stock. It is expected that this recovering will be good for two years, and by that time we will know definately if additional structures are needed for storage purposes.

STATEMENT OF RECEIPTS AND SALES OF SURPLUS WAR MATERIAL

	Expenditures	*Sales*	*Inventory value*
1919	$59,211.78	$7,999.38	$51,212.40
1920	41,449.66	15,207.88	26,241.78
1921	35,379.00	25,733.74	9,645.26
1922	36,466.87	23,960.88	12,505.99
1923	24,217.37	43,658.15	Cr. *19,440.78*
1924	13,087.71	17,502.48	Cr. *4,414.77*
Totals	$209,812.39	$134,062.51	$75,749.88
By transfer to Reno plant accounts			$46,024.32
Net investment surplus war material, November 30, 1924			$29,725.56

THE DEPARTMENT'S ANNUAL TRAFFIC CENSUS

During the week July 21 to 27, inclusive, 1924, the eighth annual count of traffic on the state highway system was made by traffic observers of the Department at 29 traffic stations located at various points throughout the State.

The tables following show in summarized form this count at the various stations and compares the count for the years 1922, 1923, and 1924. In addition we classify the traffic by total volume and at typical stations.

In Table 1 we have the count by stations, totaled for the full seven days, and with the daily average of each class of vehicle established and compared with the 1922 and 1923 count at the same station. It will be noted that there are some rather remarkable increases in traffic over the previous year; at the same time there are equally remarkable decreases at certain stations. The 1924 count proves conclusively that there was a considerable increase in tourist travel during 1924 when considered from the standpoint of total volume of traffic as shown in Table 2, and this increase came about in spite of the very serious effect on tourist travel resulting from the foot-and-mouth disease in California and the fumigation stations on our western border. This increase in tourist travel was approximately 26 per cent, whereas, had conditions been normal, there would undoubtedly have been a much greater increase in this class of travel.

Table 2 compares the total volume of 1924 traffic with that of 1923, and in the summary shows the total increase of the 1924 total over 1923 to be approximately 33 per cent. This would probably be a fair representation of the increase in total volume of traffic throughout the State, and it can readily be seen what is going to happen to our roads with an annual traffic increase of 33 per cent.

In Table 3 we have a comparison of 1923 and 1924 traffic at typical stations on the various highway routes, with a classification of the traffic in percentages.

As an illustration of the effect of improved highways, the increase in traffic over the Reno-Carson highway in 1924 was 407 per cent over 1917, and on the Yerington-Wellington road the 1924 increase over 1922 was 130 per cent.

TABLE NO. 1

Traffic Survey

	1922 July 21–27	*Daily Average*	*1923 July 21–27*	*Daily Average*	*1924 July 21–27*	*Daily Average*
Reno-Carson (½ mi. from Reno)—						
Total vehicles	8,887	1,270	12,776	1,825	15,416	2,202
Trucks	402	57	375	54	865	123
Foreign cars	642	92	1,726	247	1,976	282
Nevada cars	7,522	1,075	10,450	1,493	12,313	1.759
Horse-drawn and motorcycles	321	46	225	32	262	37

Reno-Sparks—	*1922 July 21–27*	*Daily Average*	*1923 July 21–27*	*Daily Average*	*1924 July 21–27*	*Daily Average*
Total vehicles	11,379	1,626	15,643	2,235	19,663	2,235
Trucks	658	94	1,194	171	1,391	171
Foreign cars	610	87	1,728	247	2,501	247
Nevada cars	9,812	1,402	12,315	1,759	15,428	1,759
Horse-drawn and motorcycles	299	43	406	58	343	49
Verdi Detour (½ mi. West)—						
Total vehicles	......	......	......	......	4,900	700
Trucks	......	......	......	......	246	35
Foreign cars	......	......	......	......	1,192	170
Nevada cars	......	......	......	......	3,304	472
Horse-drawn and motorcycles	......	......	......	......	158	23
Reno-Purdy (2 mi. N. Reno)—						
Total vehicles	......	......	......	......	3,730	533
Trucks	......	......	......	......	265	38
Foreign cars	......	......	......	......	805	115
Nevada cars	......	......	......	......	2,601	372
Horse-drawn and motorcycles	......	......	......	......	59	8
2 mi. S. Yerington—						
Total vehicles	1,536	219	2,525	361	3,508	501
Trucks	......	......	306	44	390	56
Foreign cars	......	......	54	8	73	10
Nevada cars	......	......	2,028	290	2,880	411
Horse-drawn and motorcycles	......	......	137	20	165	24
Walsh's Ranch (Ostermann Grade)—						
Total vehicles	......	......	1,490	213	1,408	201
Trucks	......	......	13	2	58	8
Foreign cars	......	......	708	101	611	87
Nevada cars	......	......	634	91	725	103
Horse-drawn and motorcycles	......	......	135	19	14	2
1 mi. W. Battle Mountain—						
Total vehicle	......	......	......	......	526	75
Trucks	......	......	......	......	32	5
Foreign cars	......	......	......	......	134	19
Nevada cars	......	......	......	......	353	50
Horse-drawn and motorcycles	......	......	......	......	7	1
½ mi. East Austin—						
Total vehicles	......	......	1,470	210	409	58
Trucks	......	......	114	16	29	4
Foreign cars	......	......	403	58	184	26
Nevada cars	......	......	809	116	194	28
Horse-drawn and motorcycles	......	......	144	22	2	

	1922 July 21–27	*Daily Average*	*1923 July 21–27*	*Daily Average*	*1924 July 21–27*	*Daily Average*
4 mi. N. Winnemucca—						
Total vehicles	......	......	1,199	171	549	79
Trucks	......	......	217	31	69	10
Foreign cars	......	......	131	19	66	9
Nevada cars	......	......	761	109	408	58
Horse-drawn and motorcycles	......	......	90	13	6	1
1 mi. S. Winnemucca—						
Total vehicles	......	......	1,324	178	1,122	160
Trucks	......	......	103	15	56	8
Foreign cars	......	......	348	50	299	43
Nevada cars	......	......	855	122	753	108
Horse-drawn and motorcycles	......	......	18	3	14	2
½ mi. N. Lovelock—						
Total vehicles	......	......	1,452	208	3,342	477
Trucks	......	......	42	6	37	5
Foreign cars	......	......	240	34	328	44
Nevada cars	......	......	1,044	149	2,869	410
Horse-drawn and motorcycles	......	......	126	18	108	15
Gardnerville-Minden—						
Total vehicles	5,248	750	5,972	853	6,355	908
Trucks	620	88	434	62	544	78
Foreign cars	359	51	1,092	156	856	122
Nevada cars	3,929	562	4,223	603	4,799	686
Horse-drawn and motorcycles	340	49	223	32	156	22
Wadsworth Junction, Lincoln Highway—						
Total vehicles	......	......	829	118	556	79
Trucks	......	......	35	5	40	6
Foreign cars	......	......	221	32	144	21
Nevada cars	......	......	503	72	349	50
Horse-drawn and motorcycles	......	......	70	10	23	3
Wadsworth Junction, Victory Highway—						
Total vehicles	......	......	393	56	366	52
Trucks	......	......	6	1	11	2
Foreign cars	......	......	280	40	269	38
Nevada cars	......	......	89	13	86	13
Horse-drawn and motorcycles	......	......	18	3		
Salt Wells, Lincoln Highway—						
Total vehicles	......	......	425	61	515	75
Trucks	......	......	38	5	81	12
Foreign cars	......	......	242	35	212	30
Nevada cars	......	......	145	21	217	31
Horse-drawn and motorcycles	......	......	......	......	5	1

	1922 July 21–27	*Daily Average*	*1923 July 21–27*	*Daily Average*	*1924 July 21–27*	*Daily Average*
1 mi. W. Fallon—						
Total vehicles	1,054	151	3,394	485	3,472	496
Trucks	70	10	315	47	162	23
Foreign cars	53	8	351	50	381	54
Nevada cars	893	128	2,548	364	2,754	393
Horse-drawn and motorcycles	38	5	180	26	175	25
Leeteville, Lincoln Highway—						
Total vehicles	......	......	895	128	1,041	149
Trucks	......	......	35	5	63	9
Foreign cars	......	......	224	32	251	36
Nevada cars	......	......	615	88	714	102
Horse-drawn and motorcycles	......	......	21	3	13	2
Leeteville-Carson Road—						
Total vehicles	......	......	346	49	498	71
Trucks	......	......	13	2	26	4
Foreign cars	......	......	67	10	136	19
Nevada cars	......	......	258	37	325	46
Horse-drawn and motorcycles	......	......	8	1	11	2
1 mi. east of Elko—						
Total vehicles	......	......	1,041	149	2,026	289
Trucks	......	......	70	10	130	19
Foreign cars	......	......	292	42	346	49
Nevada cars	......	......	656	94	1,532	219
Horse-drawn and motorcycles	......	......	23	3	18	3
½ mi. west of Elko—						
Total vehicles	......	......	901	129	997	142
Trucks	......	......	49	7	68	10
Foreign cars	......	......	237	34	217	31
Nevada cars	......	......	597	85	697	100
Horse-drawn and motorcycles	......	......	18	3	15	2
Ely-McGill-W. P. Co.—						
Total vehicles	......	......	......	......	2,418	346
Trucks	......	......	......	......	274	39
Foreign cars	......	......	......	......	410	59
Nevada cars	......	......	......	......	1,711	245
Horse-drawn and motorcycles	......	......	......	......	23	3
Ely-Connors—						
Total vehicles	......	......	196	28	1,165	166
Trucks	......	......	83	12	197	28
Foreign cars	......	......	74	11	213	30
Nevada cars	......	......	37	5	723	103
Horse-drawn and motorcycles	......	......	2	......	32	5

Ely to Keystone—	*1922 July 21–27*	*Daily Average*	*1923 July 21–27*	*Daily Average*	*1924 July 21–27*	*Daily Average*
Total vehicles	......	......	2,189	313	2,889	413
Trucks	......	......	304	43	380	54
Foreign cars	......	......	392	56	435	62
Nevada cars	......	......	1,372	196	2,051	293
Horse-drawn and motorcycles	......	......	121	17	23	3
6 mi. N. Tonopah—						
Total vehicles	......	......	597	85	692	99
Trucks	......	......	86	12	49	7
Foreign cars	......	......	115	16	93	13
Nevada cars	......	......	394	56	547	78
Horse-drawn and motorcycles	......	......	2	......	3	
W. Walker Lake—						
Total vehicles	......	......	216	31	196	28
Trucks	......	......	31	4	16	2
Foreign cars	......	......	43	6	21	3
Nevada cars	......	......	141	20	147	21
Horse-drawn and motorcycles	......	......	1	......	12	2
Miller's, Esmeralda County—						
Total vehicles	......	......	538	77	720	103
Trucks	......	......	16	2	70	10
Foreign cars	......	......	117	17	93	13
Nevada cars	......	......	386	55	538	17
Horse-drawn and motorcycles	......	......	19	3	19	3
Tonopah-Goldfield—						
Total vehicles	......	......	1,289	184	936	133
Trucks	......	......	71	10	9	1
Foreign cars	......	......	117	17	82	12
Nevada cars	......	......	1,064	152	844	121
Horse-drawn and motorcycles	......	......	37	5	1	
3 mi. east of Las Vegas—						
Total vehicles	......	......	......	......	803	115
Trucks	......	......	......	......	48	7
Foreign cars	......	......	......	......	375	54
Nevada cars	......	......	......	......	366	52
Horse-drawn and motorcycles	......	......	......	......	14	2
Ely-Tonopah—						
Total vehicles	......	......	886	124	939	134
Trucks	......	......	265	38	200	29
Foreign cars	......	......	143	20	173	25
Nevada cars	......	......	444	63	542	77
Horse-drawn and motorcycles	......	......	34	5	24	3

Minden Road—	*Sept. 1–7*	
Total vehicles	1,616	231
Trucks	87	12
Foreign cars	357	51
Nevada cars	1,122	160
Horse-drawn and motorcycles	50	7
Genoa and Lake Road—		
Total vehicles	482	60
Trucks	58	8
Foreign cars	133	19
Nevada cars	247	35
Horse-drawn and motorcycles	44	6
Mountain House-Holbrook—	*Sept. 8–14*	
Total vehicles	728	104
Trucks	148	21
Foreign cars	306	44
Nevada cars	270	39
Horse-drawn and motorcycles	4	1

TABLE NO. 2

Total Volume—By Routes

ROUTE No. 1

	1924	*1923*	*% Increase 1924 over 1923*	*1924 Classification*
Vehicles	32,942	20,754	58.7	
Trucks	1,971	1,464	34.6	6.0
Foreign cars	5,286	3,125	69.2	16.1
Nevada cars	25,027	15,556	60.9	75.9
Horse-drawn	658			2.0
ROUTE No. 2				
Vehicles	11,300	9,202	22.8	
Trucks	1,029	841	22.4	9.1
Foreign cars	2,017	1,833	.1	17.8
Nevada cars	7,990	5,992	33.3	70.8
Horse-drawn	264			2.3

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

The Mining Industry in Nevada

Upper left—The old Silver Camp of Austin on the central highway through Nevada.

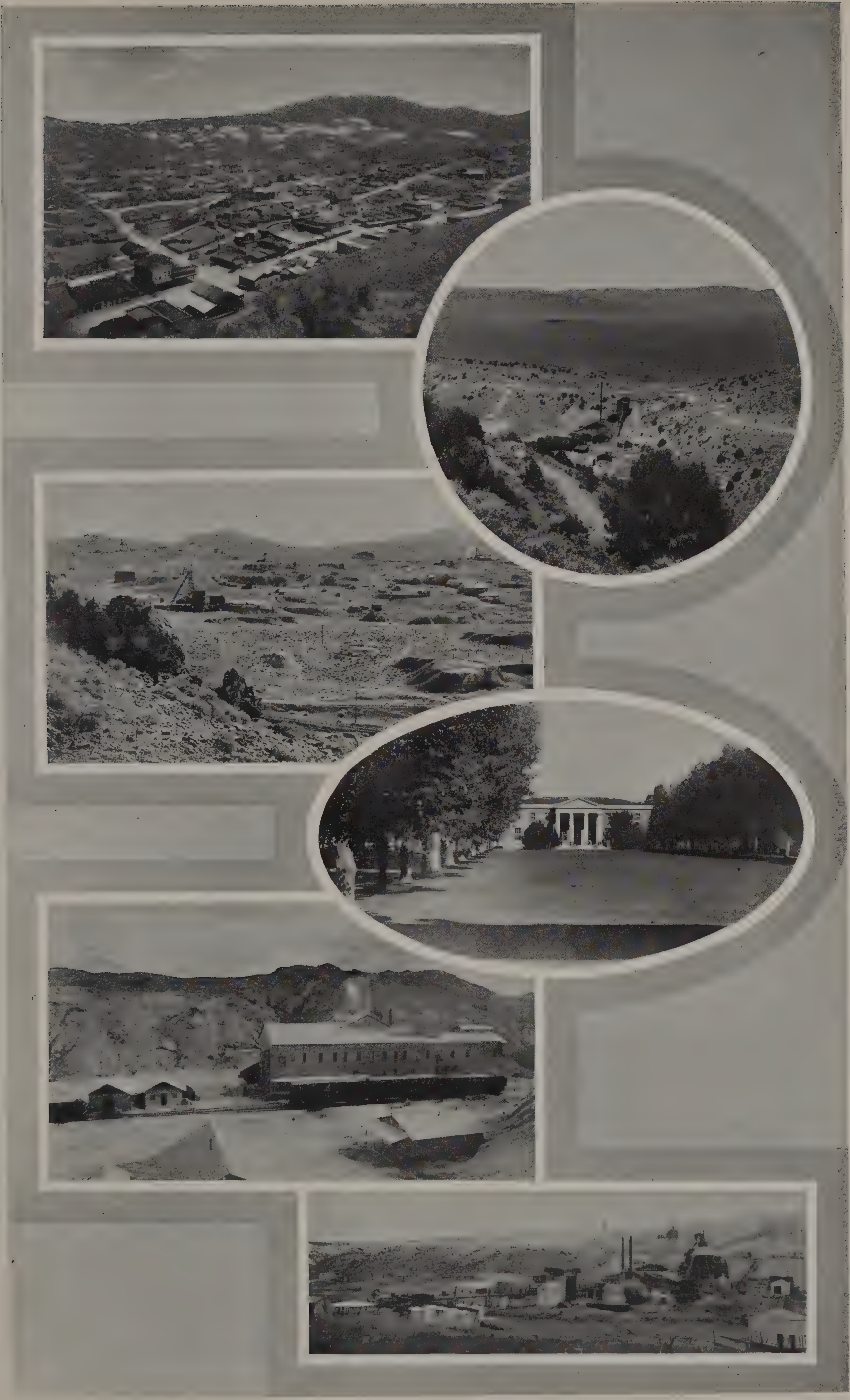
Upper right circle—An old stamp mill near Austin.

Center square—The old bonanza workings of the great Gold Camp of Goldfield.

Center oval—The Mackey School of Mines, University of Nevada.

Lower left—The U. S. Gypsum Plant near Moapa in Clark County.

Lower right—The Catlin Shale Oil Plant near Elko in Elko County.



ROUTE No. 2–A	*1924*	*1923*	*% Increase 1924 over 1923*	*1924 Classification*
Vehicles	498	346	43.9	
Trucks	26	13	100.0	5.2
Foreign cars	136	67	102.9	27.3
Nevada cars	325	258	25.9	65.3
Horse-drawn	11	....	......	2.2
ROUTE No. 3				
Vehicles	28,539	24,806	15.0	
Trucks	1,952	1,246	56.7	6.8
Foreign cars	3,712	3,857	–.4	13.0
Nevada cars	22,246	18,926	17.6	78.0
Horse-drawn	629	....	......	2.2
ROUTE No. 7				
Vehicles	1,165	196	494.4	
Trucks	197	83	137.4	17.0
Foreign cars	213	74	187.9	18.4
Nevada cars	723	37	1,854.1	62.2
Horse-drawn	32	....	....	2.4
ROUTE No. 8				
Vehicles	549	1,199	–54.2	
Trucks	69	217	–68.2	12.6
Foreign cars	66	131	–49.7	12.0
Nevada cars	408	761	–46.4	74.3
Horse-drawn	6	....	....	1.1
Total vehicles	74,983	56,503	32.7	
Total trucks	5,244	3,864	35.8	7.0
Total foreign cars	11,430	9,087	25.8	15.2
Total Nevada cars	56,719	41,530	36.6	75.6
Total horse-drawn	1,590	2,022	–21.4	2.2

(– indicates loss in 1924 traffic compared with 1923.)

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

The Mining Industry in Nevada

Upper left—The old Silver Camp of Pioche, still producing, Lincoln County.

Upper center oval—A view of Ruth, Nevada, one of the industrial towns of the Ely district.

Upper right—The great copper pit near Ruth, a hole in the face of the earth which could absorb all of the material excavated from the Panama Canal.

Lower left—Virginia City, the great Comstock. Largest producer of silver ore in the world.

Lower center circle—American City, the new mine development near Gold Hill, showing the huge mills.

Lower right—A railroad crossing eliminated near a mine in White Pine County.

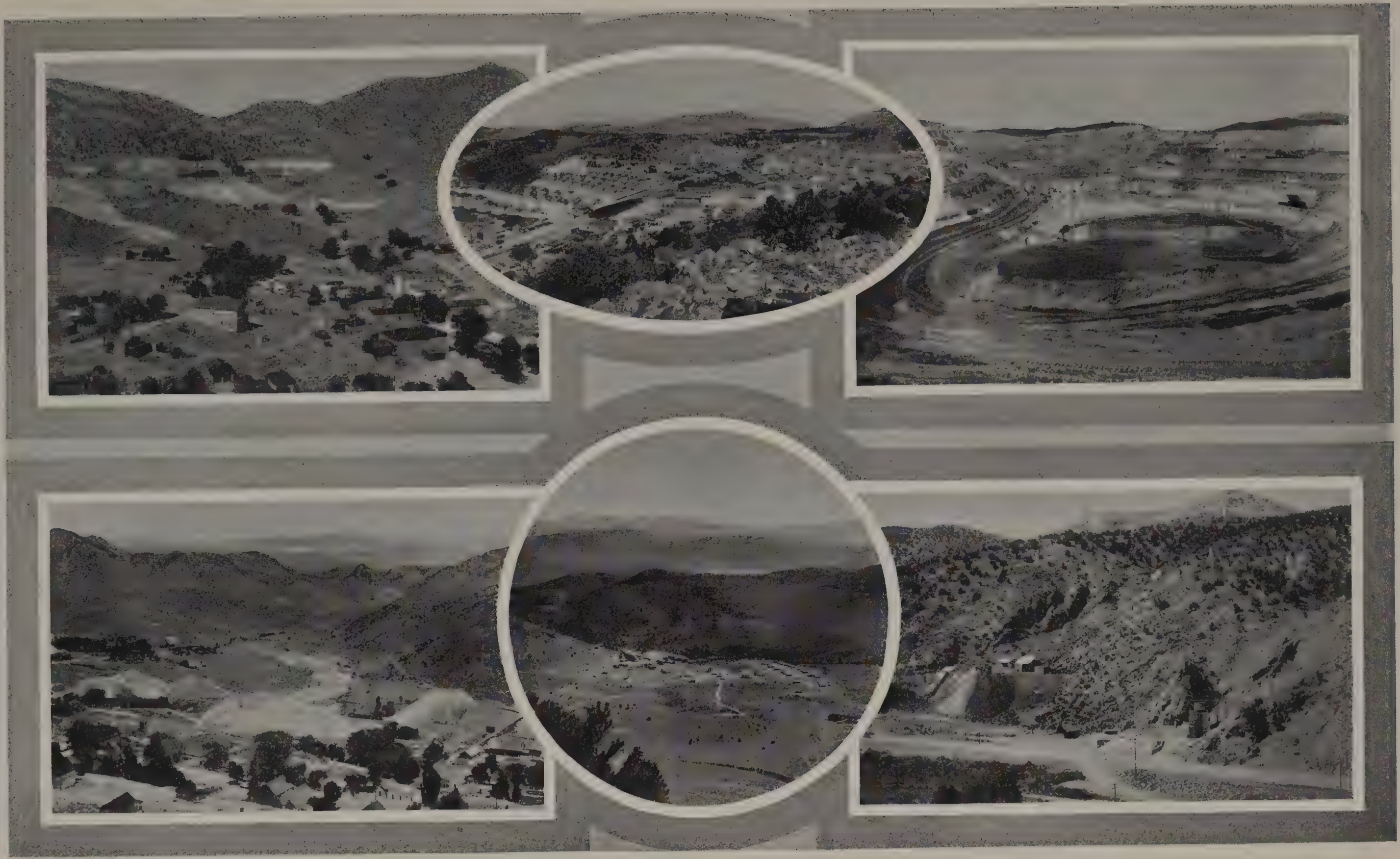


TABLE NO. 3

Classification of Traffic at Typical Stations

ROUTE No. 1

	1924	*Per cent*	*1923*	*Per cent*
½ mi. west of Reno—				
Total vehicles	4,900	100.0		
Trucks	246	5.0		
Foreign cars	1,192	24.3		
Nevada cars	3,304	67.5		
Horse-drawn	158	3.2		
Reno-Sparks—				
Total vehicles	19,663	100.0	15,643	100.0
Trucks	1,391	7.1	1,194	7.6
Foreign cars	2,501	12.7	1,728	11.1
Nevada cars	15,428	78.4	12,315	78.7
Horse-drawn	343	1.8	406	2.6
½mi. north of Lovelock—				
Total vehicles	3,342	100.0	1,452	100.0
Trucks	37	1.1	42	2.9
Foreign cars	328	9.8	240	16.5
Nevada cars	2,869	85.9	1,044	71.9
Horse-drawn	108	3.2	126	8.7
½ mi. west of Elko—				
Total vehicles	997	100.0	901	100.0
Trucks	68	6.8	49	5.4
Foreign cars	217	21.8	237	26.4
Nevada cars	697	69.9	597	66.3
Horse-drawn	15	1.5	18	1.9

ROUTE No. 2

1 mi. west of Fallon—				
Total vehicles	1,472	100.0	3,394	100.0
Trucks	162	4.7	315	9.2
Foreign cars	381	11.0	351	10.4
Nevada cars	2,754	79.3	2,548	75.1
Horse-drawn	175	5.0	180	5.3

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Recreational and Tourist Attractions in Nevada

Upper left—Mt. Wheeler and Crystal Lake near the Lehman Caves, White Pine County.

Upper right—Interior view of Lehman Cave. One of the most remarkable caverns found by man.

Center left—Stokes Castle near Austin, Lander County, Nevada. Queer monument to the whims of a wealthy man.

Center right-upper—A view of the Ruby Mountains from Clover Valley, Elko County.

Center right-lower—The majestic Toiyabe Range (sportsmen's paradise) as seen from Reese River Valley, Lander County.

Lower—Along the shore of Pyramid Lake 16 miles north of Reno.

¼ mi. east of Austin—	*1924*	*Per cent*	*1923*	*Per cent*
Total vehicles	409	100.0	1,470	100.0
Trucks	29	7.2	114	7.8
Foreign cars	184	44.9	403	27.4
Nevada cars	194	47.4	809	55.0
Horse-drawn	2	.5	144	9.8
Ely-McGill—				
Total vehicles	2,418	100.0		
Trucks	274	11.3		
Foreign cars	410	16.9		
Nevada cars	1,711	70.8		
Horse-drawn	23	1.0		

ROUTE No. 3

Reno-Carson—				
Total vehicles	15,416	100.0	12,776	100.0
Trucks	865	5.6	375	2.9
Foreign cars	1,976	12.8	1,726	13.5
Nevada cars	12,313	79.9	10,450	81.8
Horse-drawn	262	1.7	225	1.8
1 mi. west of Carson—				
Total vehicles	1,408	100.0	1,490	100.0
Trucks	58	4.1	13	.9
Foreign cars	611	43.4	708	47.5
Nevada cars	725	51.5	634	42.5
Horse-drawn	14	1.0	135	9.1
Gardnerville-Minden—				
Total vehicles	6,355	100.0	5,972	100.0
Trucks	544	8.6	434	7.3
Foreign cars	856	13.5	1,092	18.3
Nevada cars	4,799	75.5	4,223	70.7
Horse-drawn	156	2.4	223	3.7
2 mi. south of Yerington—				
Total vehicles	3,508	100.0	2,525	100.0
Trucks	390	11.1	306	12.1
Foreign cars	73	2.1	54	2.1
Nevada cars	2,880	82.1	2,028	80.3
Horse-drawn	165	4.7	137	5.5
Tonopah-Goldfield—				
Total vehicles	936	100.0	1,289	100.0
Trucks	9	1.0	71	5.5
Foreign cars	82	8.8	117	9.1
Nevada cars	844	90.2	1,064	82.5
Horse-drawn	1	---------	37	2.9

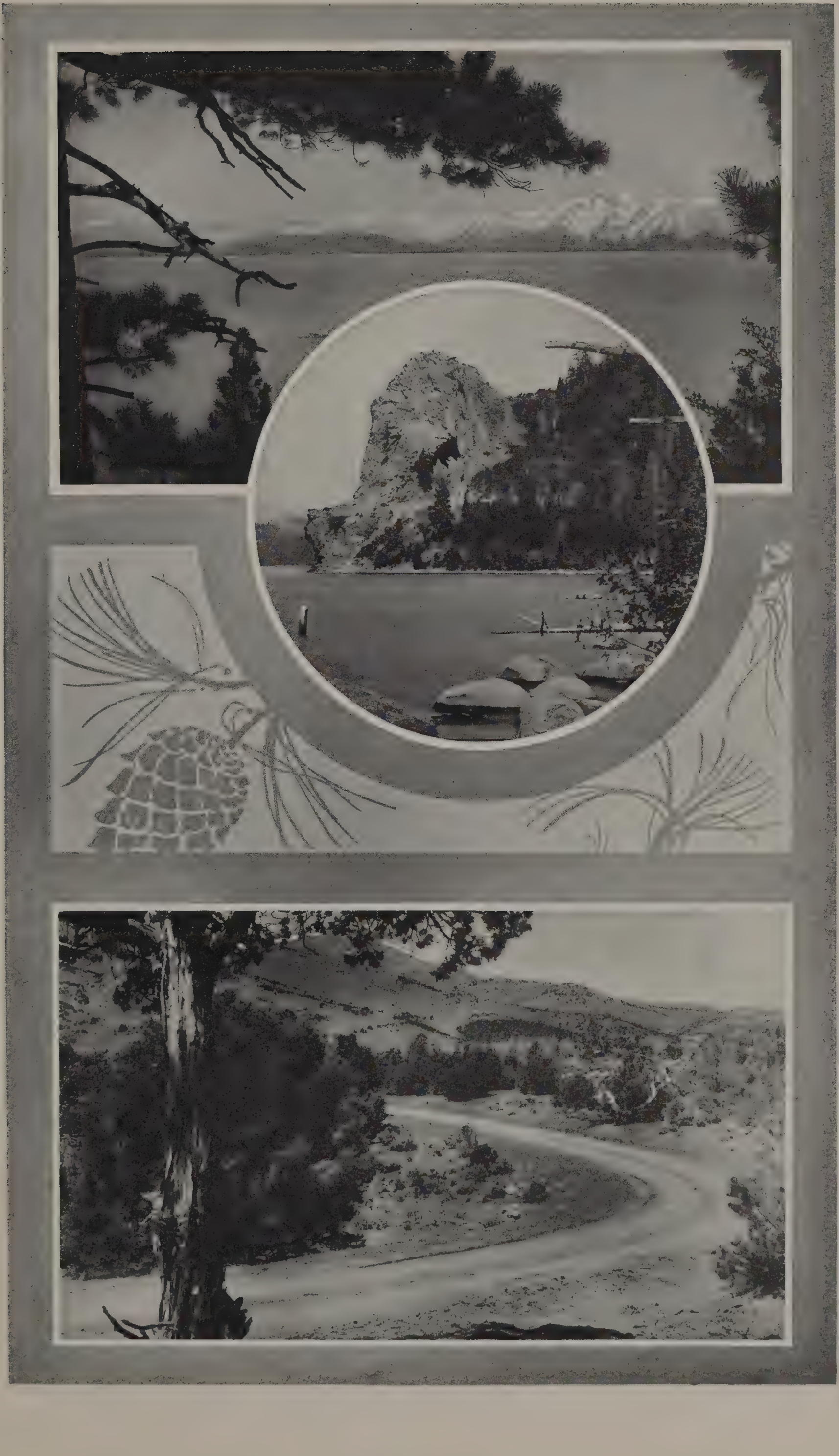
TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Tourist and Recreational Attractions of Nevada

Upper—Tahoe, gem of the skies. Without doubt the most beautiful lake in the world.

Center circle—Cave Rock on the Nevada shore of Lake Tahoe.

Lower—A forest highway project near Austin, extending over the Toiyabe Range.



ROUTE No. 4

Ely-Tonopah—	*1924*	*Per cent*	*1923*	*Per cent*
Total vehicles	939	100.0		
Trucks	200	21.3		
Foreign cars	173	18.4		
Nevada cars	542	57.8		
Horse-drawn	24	2.5		

ROUTE No. 6

3 mi. east of Las Vegas—				
Total vehicles	803	100.0		
Trucks	48	6.0		
Foreign cars	375	46.7		
Nevada cars	366	45.6		
Horse-drawn	14	1.7		

ROUTE No. 8

4 mi. north of Winnemucca—				
Total vehicles	549	100.0	1,199	100.0
Trucks	69	12.5	217	18.1
Foreign cars	66	12.1	131	10.9
Nevada cars	408	74.3	761	63.5
Horse-drawn	6	1.1	90	7.5

ROUTE No. 9

Reno-Purdy—				
Total vehicles	3,730	100.0		
Trucks	265	7.1		
Foreign cars	805	21.6		
Nevada cars	2,601	69.7		
Horse-drawn	59	1.6		

MISCELLANEOUS ACTIVITIES

Automobile License Enforcement

It has been a matter of general knowledge that the State has not been getting all the revenue possible from automobile licenses. No matter how well the various peace officers tried to enforce the law, a great many owners were able to evade the payment of licenses. Accordingly, the Department took up the matter and placed inspectors in the field. This action was justified for the reason that the receipts from motor-vehicle fees go directly to the retirement of highway bonds and the construction of additional mileage.

The inspectors rounded up over 1,100 owners who paid over $12,000

TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Agriculture and Stockraising in Nevada

Upper left—Beef cattle on the open range.

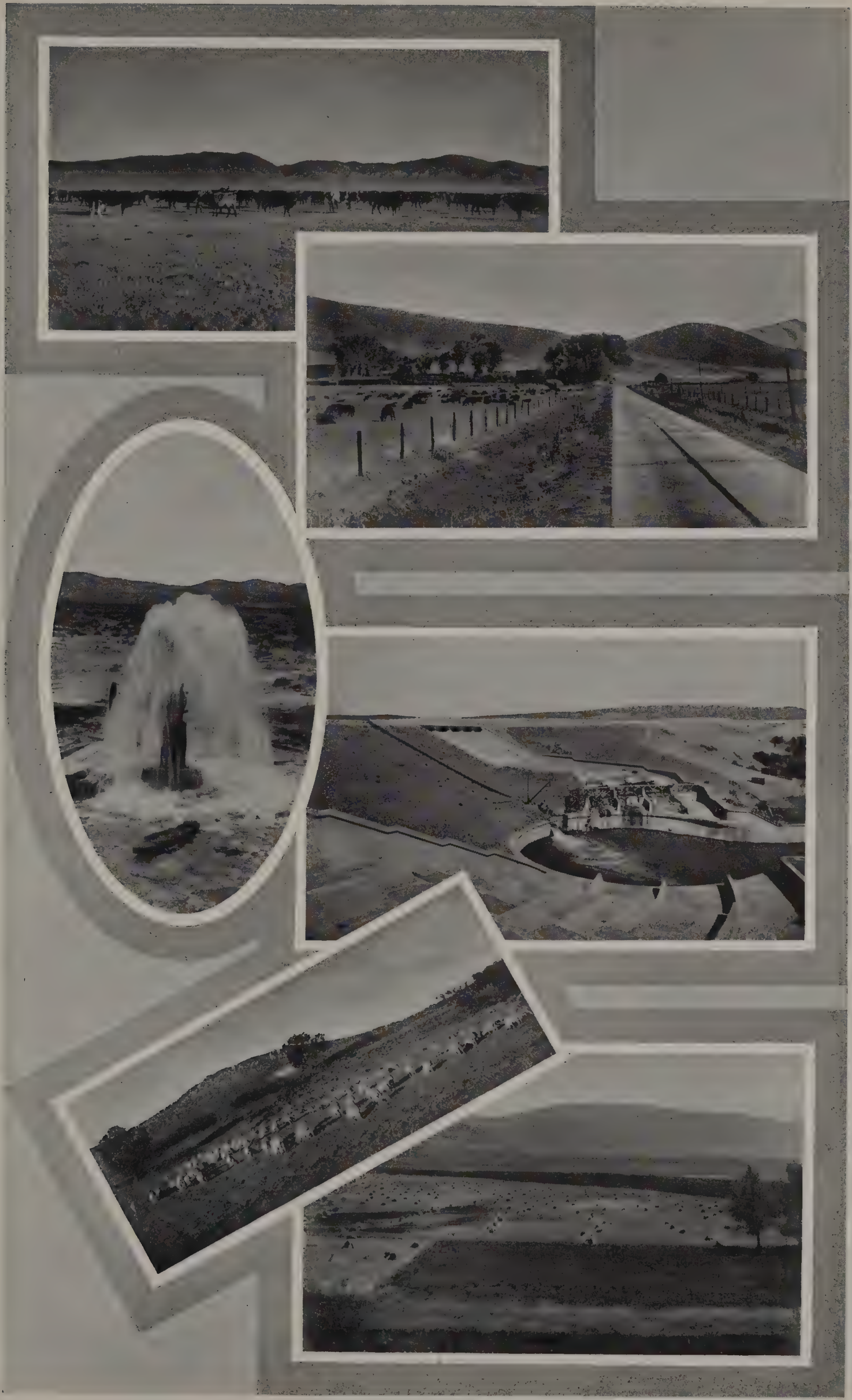
Upper right—Ranch scene alongside an improved highway.

Center oval—An artesian well flow near Las Vegas in the great artesian belt.

Center square—The great Lahontan Dam which stores the water of the Newland's Project, Uncle Sam's first Reclamation Project.

Lower left—Sheep grazing on the open range.

Bottom right—Grain fields of Washoe Valley.



in fees. There is no doubt that a great many more were forced to comply with the law through the activity of the inspectors. The inspectors were able to discover and prevent many forms of evasions. Because their work was state-wide, they were also able to detect forms of evasion that would not, by the nature of things, be apparent to local enforcement officers. In their work the inspectors were aided without stint by local officers and the result is that under the motor-vehicle law a greater proportion of the possible revenue is collected than under any other law, save real property taxes.

Another feature of the work is that a large number of vehicles were placed on the personal property rolls of the various counties. It is safe to assume that, but for the enforcement work, at least two thousand vehicles would have escaped the automobile license and assessment on the personal property rolls of the counties. As a result of this activity the state and counties received additional revenue without cost.

The work of the inspectors revealed weakness in the present law and recommendations will be made to the proper committees of the Legislature looking to a correction of the defects.

Agricultural Development

Believing that the highways of this State should help to develop the State and that it was in a position to assist, the Department has given considerable attention in the past year to the possible development of new agricultural areas. This work has been done in cooperation with the Governor's office, and southern Nevada has been the principal field of endeavor. Until recently the southern part of the State (north of Las Vegas) has been looked upon as something apart from the rest of the State and as being devoid of opportunity for development. The visits of agricultural experts arranged by the Governor and the publicity given by the Department have started a general investigation of the possibilities of the south and have removed the former misconceptions. Now that adequate roads have been constructed the investigations that have been started will result in quickened interest and before many years have passed the so-called desert of southern Nevada will be known as one of the best fields in the West for development.

It is believed that this work should be continued and during the coming year further efforts will be made to bring that section of the State to the attention of potential settlers and investors.

Road Bulletins and Maps

The Department has fallen heir to the duty of furnishing road and tourist information and has undertaken to give reliable, uncolored information. It has been in a position to collect this information from employees working all over the State, and bulletins have been issued every two weeks during the touring season. The bulletins are sought

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TITLES OF ILLUSTRATIONS ON OPPOSITE PAGE

Three Views of the Boulder Canyon Dam Site—Proposed as the World's Largest Water Storage Dam

The upper view shows the character of country above the dam, the center view looking upstream from near the site of the proposed dam, and the lower photo downstream from the site of the proposed dam.

eagerly and are furnished to practically every large touring bureau in the United States. In addition, at least two thousand inquiries were answered personally at headquarters or by mail. That this service is appreciated is attested by the numerous personal and written commendations received.

Having the facilities and data, the Department has issued maps showing the principal highway routes and containing information required by the touring public. These maps have received a wide distribution and have been no small factor in increased business for many sections.

Purchase of Supplies

In its various activities the Department requires large quantities of supplies ranging from pencils to heavy machinery. Since its organization close attention has been paid to the method of purchasing, with the result that today every article required is obtained at lowest wholesale prices. The savings effected reach a great sum and dealers are keen to obtain the business of the Department at the lowest prices.

In a few quarters the method of purchasing has been questioned, but the public generally is behind the method of purchasing supplies at the lowest possible cost. It is gratifying to be able to record that most of the dealers in the State have cooperated with the Department and are quoting prices that afford only a scant margin of profit.

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